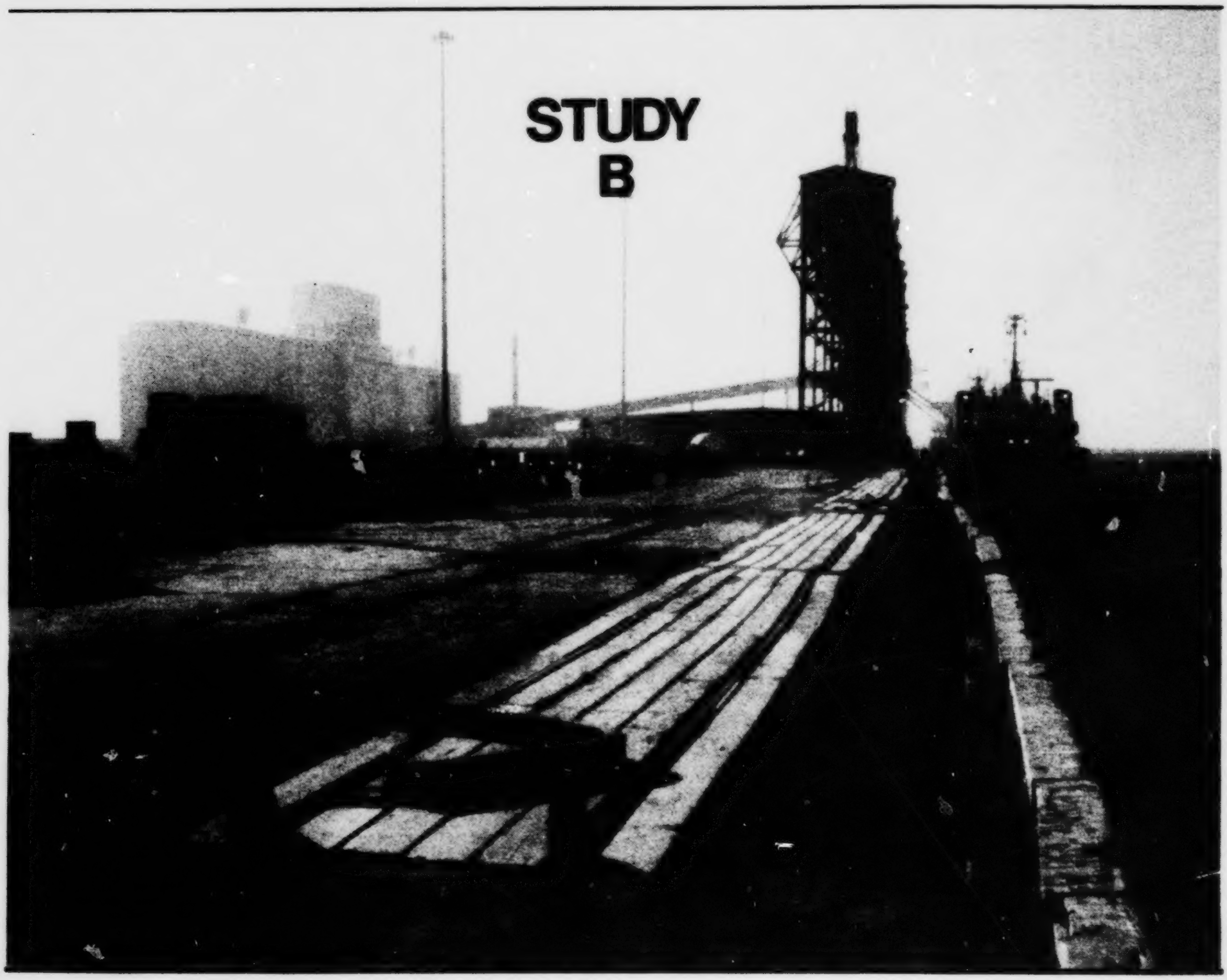
GOVERNMENT OF CANADA
Transport Canada

GOVERNMENT OF MANITOBA
Highways and Transportation

PORT OF CHURCHILL ADDITIONAL COMMODITIES



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PORT OF CHURCHILL

ADDITIONAL COMMODITIES

STUDY B

Prepared for

GOVERNMENT OF CANADA
TRANSPORT CANADA

GOVERNMENT OF MANITOBA
HIGHWAYS AND TRANSPORTATION

by

IBI GROUP

in association with

Harvey Kriss + Associates Limited

Carr & Donald & Associates

Stevenson Hluchan & Associates Ltd.

G. C. Baker

March, 1986

IBI
GROUP

March 27, 1986

Mr. P.F. Schubert
Policy Analyst
Transport Canada
22nd Floor - Tower C
Place de Ville
Ottawa, Ontario
K1A 0N5

Mr. J.B. Wallace
Executive Director
Transportation Policy
Programs and Research Division
Manitoba Department of
Highways and Transportation
215 Garry Street, 15th Floor
Winnipeg, Manitoba
R3C 3Z1

Gentlemen:

PORT OF CHURCHILL ADDITIONAL COMMODITIES
STUDY B

We respectfully submit the above report presenting our findings on the economic viability of exporting or importing additional commodities, other than Board grains through the Port of Churchill. In accordance with the contract for this work, dated July 25, 1985, this report addresses one of the four studies comprising the overall Churchill study, as follows:

A. Season Extension;

B. Additional Commodities;

C. Resupply Operations;

D. Grain Shipping Costs.

The above four studies were all carried out by IBI Group and its associated sub-consultants, on an integrated basis; the accompanying report addresses the results of Study B only. The overall findings and results of Study B are summarized in an Executive Summary of about 15 pages at the beginning of the report. The Summary follows the same structure as the main body of the report which, of course, presents the study findings and results in substantially greater detail.

We wish to acknowledge with thanks the advice and direction of the Steering Committee for this study under your co-chairmanship and the cooperation of the many people who provided information and opinions related to the study. The consultant team bears responsibility for our findings, conclusions and recommendations, as presented herein.

156 Front Street West, 6th Floor, Toronto, Canada M5J 2L6 Cable Address IBIGRP, (416) 596-1930
IBI is a group of companies practising professional consulting and is affiliated with BIA Beinhaker/Irwin Associates Architects, Engineers, Planners

We hope that the economic comparisons presented in this report will assist the Government of Canada, the Government of Manitoba and other interested parties in reaching the most appropriate policy position regarding the Port of Churchill, in the long term interests of the country.

Yours sincerely,

IBI GROUP

Lee S. Sims

Neal A. Irwin
Managing Director

Lee S. Sims
Director

NAI/LSS/wp
Encl.

The contents of this report reflect the opinions of the Consultant and are not to be construed as the official policy of Transport Canada or Manitoba Highways and Transportation.

Dimensions and measurements contained in this report may appear in both imperial and metric units as a reflection of common usage and standard practice of the transportation industry.

ACKNOWLEDGMENT OF PARTICIPATION

This Study (Port of Churchill Additional Commodities) was conducted on behalf of the Government of Canada, Transport Canada, and the Government of Manitoba, Department of Highways and Transportation, under the Canada-Manitoba Subsidiary Agreement on Churchill.

Consultant support to the IBI Group, the main consultants, was provided by the following firms:

Harvey Kriss + Associates Limited - Planning and Management Consultants

Carr & Donald & Associates - Consulting Engineers (Materials Handling)

Stevenson Hluchan & Associates Ltd. - Consulting Engineers (Marine and Harbour Facilities)

G. C. Baker - Transportation Consultant (Commodity Movements)

A multi-disciplinary steering committee composed of representatives from Transport Canada and the Manitoba Department of Highways and Transportation provided overall direction and facilitated information exchange with relevant organizations and individuals. The governments of the Province of Alberta and the Province of Saskatchewan also provided senior support to the steering committee and the study.

The contribution of all participants is gratefully acknowledged. Responsibility for the findings and conclusions presented herein rests with the consultants.

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PORT OF CHURCHILL ADDITIONAL COMMODITIES STUDY

STUDY B

EXECUTIVE SUMMARY

1. STUDY OBJECTIVE AND SCOPE

This study was conducted on behalf of the Government of Canada, Transport Canada, and the Government of Manitoba, Department of Highways and Transportation, under the Canada-Manitoba Subsidiary Agreement on Churchill. It is part of an overall study of the Port of Churchill conducted on an integrated basis by IBI Group and its associated consultants, with the following components:

- Study A: Season Extension;
- Study B: Additional Commodities;
- Study C: Resupply Operations;
- Study D: Grain Shipping Costs.

This Executive Summary provides a brief overview of the objective, scope, major findings and conclusions of Study B.

Objective

As stated in the Terms of Reference, the study objective is:

- "....to identify economically viable ways to increase the utilization of the Port of Churchill as a gateway to and from off-shore markets."

Study Scope

The scope of the study is to identify markets for commodities produced or consumed in Manitoba, Saskatchewan and Alberta which move to or from Northern or Central Europe or other areas that may be competitively served from the Port of Churchill. In addition to other potential new commodity flows that may be identified, consideration is required of the economic feasibility of:

- shipment of ores from Nanisivik through Churchill to the smelter at Flin Flon;
- refinement at Churchill of crude oil from Bent Horn and the supply from Churchill of petroleum fuels to the Eastern Arctic;
- drying at and exporting from Churchill corn produced in the northern border areas of North Dakota and Minnesota; and
- handling of inbound shipments of alumina.

In addition the study is to provide an updated inventory of existing facilities and services at the Port of Churchill, including rail support, transshipment facilities and marine support services, relevant to additional commodities. The study is to identify and assess institutional concerns which may affect movement of additional commodities to the Port and is to identify sites at or near the Port which would be appropriate for storage, handling and transshipment of the additional commodities identified in the study. New facilities of this type are to be identified if required and their capital costs estimated.

The study is to provide a comparative analysis of the relative costs of shipping the additional commodities through Churchill and through alternative routings (e.g. the Great Lakes/St. Lawrence Waterway or the Port of Vancouver). This comparison will use similar methods and draw upon the results of the grain shipping costs developed in Study D, and the comparison will provide a basis for selecting those additional commodities for which shipment through Churchill may be economically competitive. For any such commodity, estimates will be made of the rates which would have to be charged to generate a commercial return to the operator. The study is to identify exporters and importers located in the four Western provinces of Canada which could potentially utilize facilities and will identify relevant requirements for Port services at Churchill. Attention is to be paid to any cost advantages and disadvantages or other concerns of ship owners regarding the use of Churchill, any other problems which shippers may have with using Churchill, and suggested solutions to these problems. It will assess the impact, if any, which the handling of additional commodities would have on the Port's capacity to handle grain.

For any products and markets for which Churchill is found to be a viable Port of exit or entry, the study is to outline an action plan for improving the utilization of Churchill.

Methodology

The methodology adopted was to develop an initial long list of potential commodities and then subject this list to a number of tests or successive screenings in terms of the suitability of the commodity for movement through Churchill and the relative economics of that movement compared with the export/import channel now used in each case.

The sections of this Executive Summary mirror the chapter structure of the main report.

2. CANDIDATE COMMODITIES FOR MOVEMENT THROUGH CHURCHILL

Potential movements to be included in the long list were identified using both of the following two criteria:

- the commodity must move to/from West Coast Mainland Ports or Thunder Bay from/to Atlantic Ports in sufficient quantities (over 25,000 tonnes annually);
- the product must move to/from the Prairie provinces from/to marine import/export by rail in sufficient quantities (over 25,000 tonnes annually).

This assumes that any export/import commodities moving from/to the Prairies in significant volumes by truck and air are unlikely to shift to movement by rail to/from Churchill.

The 25,000 tonne limit used in the above criteria represents one full ship load of movement for typical vessels using Churchill. Since not all of these movements would be attracted to Churchill, commodities with annual movements of less than 25,000 tonnes would move in at most one load or a few partial ship load quantities each year such that any investment required at the Port of Churchill to handle these relatively insignificant movements is highly unlikely to be economic compared to established movement channels.

Based on these criteria and related considerations as described in Section 2.1 of the report, the following commodities were retained in the long list, based on present movements:

Exports	Imports
o Wheat;	o Phosphate Rock
o Barley;	
o Rapeseed;	
o Fodder and Feed;	
o Rye;	
o Flaxseed;	

- Sulphur;
- Coal;
- Wood Pulp;
- Potash.

Through personal and telephone contacts with relevant government agencies and private companies, and drawing on the judgment of the Study Team, an assessment was made of relevant potential commodity movements that may occur in the future. The resulting additions to the list of potential commodities are as follows:

- fertilizers and fertilizer ingredients including those that are ammonia based and urea based;
- alumina inbound and aluminum products outbound, if a proposed smelter in Manitoba is built;
- forest products;
- farm machinery and implements both inbound and outbound;
- Arctic ores;
- Arctic oil;
- North Dakota grains;
- liquor imports from Northwestern and Eastern Europe.

This list of future potential commodities was added to the early list of potential commodities based solely on current movements, to give a long list of potential commodities.

3. ANALYSIS OF POTENTIAL COMMODITIES

The various commodities identified as having some possibility of moving through the Port of Churchill were then examined in terms of their movement characteristics. Based on this examination, some commodities were then removed from further consideration.

The reasons for removing commodities from the list at this stage of the analysis are discussed at length in Section 3.1 of the report. They include the following:

- rail rate disadvantage owing to the distance from Churchill of the origin or destination of the commodity in Canada;
- institutional constraints;
- extreme variability of annual movements;
- seasonality considerations;
- costs of stockpiling product required by the relatively short existing Churchill shipping season;
- cost competition for Canadian export commodities from other countries;
- diseconomies of importing commodities which are already produced in Canada;
- postponement of plans for further Canadian processing/export of commodities owing to weak world markets;
- postponement of mine developments for similar reasons and diseconomies of processing certain ores in Canada; and
- lower transportation costs via other Canadian ports of entry/exit or via other modes such as rail and/or truck for serving North American origins/destinations.

The first screening process resulted in a short list of commodities as follows:

Exports	Imports
o Sulphur;	o Phosphate Rock
o Coal;	
o Potash.	

A comparison of the cost of moving the product through Churchill with the cost via other potential routes was then performed (described in Section 3.2) for the short list of commodities.

As shown in Exhibit 3.2 of the report, the main origins of sulphur moving through Churchill would be Ram River, Medicine Hat and Edmonton, Alberta,and the main destinations for sulphur would be eastern South America (e.g. Brazil, Argentina), Africa, Europe and the USSR. The main origin for coal moving through Churchill is Central Alberta and the main destinations would be Europe and Brazil. The main origins for potash moving through Churchill are Rocanville, Estherhazy, Saskatoon and Regina, Saskatchewan, and the main destination would be Brazil. The origin for phosphate rock imported through Churchill is Florida and the main destinations would be Redwater and Calgary, Alberta.

The three short listed export commodities and the one short listed import commodity were then subjected to substantially more detailed cost analysis, as described in section 3.2 of the report. Schedules of rail and marine rates were developed and cost comparisons were carried out for the relevant alternate routes and modes, including terminals/ transshipment costs.

Eight scenarios of individual bulk commodity movements were subjected to these detailed cost comparisons. Based on this it was found that three of the movements show some possibility of being economic compared to the current movements through Vancouver. For these individual movements, namely sulphur to Europe, sulphur to the USSR and potash to Brazil, Churchill would offer the lowest shipping cost of the three routes considered if the Churchill terminal and any additional rail associated costs are less than $5.50 per tonne for sulphur to Europe, $5.10 per tonne for sulphur to the USSR and $12.85 per tonne for potash to South America, under medium ocean freight market conditions. These three potential movements were therefore carried forward for further analysis.

For the other movements, the per tonne amounts available to cover terminal handling costs and any extra rail associated costs at Churchill are shown to be negative. These movements include sulphur to Argentina and Brazil, sulphur to Northwest Africa, coal to Europe, coal to Brazil, and phosphate rock from Florida. Shipping through Thunder Bay is more expensive than shipping through Churchill for each of the eight additional commodity movements included in this comparison. There is also no margin available for terminal costs in Thunder Bay, compared with Vancouver, except in the case of potash movements. The Thunder Bay route was therefore left out of additional comparisons.

Since phosphate rock movements from Florida could serve as a back haul to outbound potash and/or sulphur to reduce the total cost of combined movement, the phosphate rock movement was also retained for more detailed analysis. The above analysis included rates for transportation and handling only and no allowance was made for any extra costs introduced by the short season at Churchill and resulting stockpiling requirements. This was addressed in a subsequent analysis as outlined below.

Various combinations of sulphur, potash and phosphate movements through the Port of Churchill were also examined in terms of costs relative to the alternate of routing through Vancouver. The reason that joint commodity scenarios were examined is that using the Port of Churchill to handle more than one non-grain commodity movement would increase the total volume of product handled through the Port and might therefore reduce the unit terminal handling costs at the Port through economies of scale. Based on this, seven individual and combined commodity movements through the Port of Churchill were retained for more detailed analysis of terminal costs in Churchill and any additional rail costs associated with Churchill movements:

- sulphur to Europe and USSR during the Churchill navigation season;
- potash to South America during the Churchill navigation season;

- potash to South America with year-round rail shipment to Churchill;
- sulphur to Europe and USSR and potash to South America during the Churchill navigation season;
- sulphur to Europe and USSR and potash to South America with year-round rail shipment of potash to Churchill;
- sulphur to Europe and USSR, potash to South America with phosphate rock back hauled from Florida, moved only during the Churchill navigation season;
- sulphur to Europe and USSR, potash to South America with phosphate rock back hauled from Florida and year-round rail shipment of potash and phosphate rock to/from Churchill.

4. PORT OF CHURCHILL TERMINAL FACILITIES AND COSTS

Chapter 4 of the report describes the existing facilities for commodity handling at the Port of Churchill and assesses improvements required to enable the Port to handle additional bulk commodities and the terminal charges which would be required to provide a commercial return on such facilities.

Eight basic material handling schemes for the inbound and outbound non-grain commodities retained for this analysis were investigated to obtain:

- an assessment of throughput capacity achievable;
- order of magnitude capital and operating costs;
- identification of limitations and restrictions as well as relative advantages and disadvantages.

Detailed descriptions of the schemes, including sketch plans and summaries of related costs, operating features and limitations, are presented in Appendix E of the report.

In the investigation of material handling requirements, the range of possible volumes of inbound and outbound bulk commodities was from 72,500 tonnes to 1.4 million tonnes, based on the analyses of Chapter 3 as outlined above. As shown in Exhibit 4.2 of the report, the average total costs per tonne for handling the candidate inbound or outbound commodities range from $7.05 (for the movement of 800,000 tonnes of outbound sulphur and potash and inbound phosphate rock) to $39.08 (for the movement of 72,500 tonnes of outbound potash). As would be expected, rates are substantially lower for higher throughputs.

5. OVERALL COST COMPARISON FOR POTENTIAL BULK COMMODITY MOVEMENTS THROUGH THE PORT OF CHURCHILL

Chapter 5 of the report presents comparisons of the total costs to shippers of moving each of the seven combinations of bulk commodities listed at the end of Section 3 above through the Port of Churchill versus through Vancouver. These final comparisons take into account the potential terminal charges at Churchill estimated in Chapter 4, as well as additional costs associated with the requirement to upgrade the Churchill rail line to accommodate conventional hopper and open gondola cars. The latter analysis compares the costs of using articulated hopper cars on the Churchill rail line versus refurbishing the rail line to use conventional hopper cars, drawing upon the more detailed analysis carried out in Study D. The results of these analyses show that, based upon information now available, refurbishment of the Churchill line would be more economical than using articulated hopper cars for additional commodities when more than 350,000 tonnes of all commodities (including grain) are moved over the line each year. A similar analysis of the trade-off between refurbishment of the line and purchase of specialized cars reported on Study D resulted in a higher estimate of the volume of grain required to make refurbishment of the line preferable, because of the potential use of the Churchill articulated hopper cars on load restricted branch lines during the remainder of the year.

As noted in Study D, comparisons between these rail car/rail line refurbishment options must be considered preliminary at this time until the more detailed cost information and testing results are available from a current study being carried out by CN under the Canada-Manitoba Subsidiary Agreement on Churchill. While the articulated hopper cars appear to be more viable for grain movement based on the preliminary information, the results noted here for additional commodities suggest that, if the economic comparisons are quite close, it might be preferable to select the option of refurbishing the rail line, since this would more effectively keep the option open of moving additional commodities through Churchill in future years.

Exhibit 5.3 in the report presents the overall comparison of the cost to shippers of moving each of the various combinations of potash, sulphur and phosphate rock identified in Section 3 above as potential movements to/from Churchill relative to the costs of moving them through Vancouver, including terminal costs at Churchill and costs for refurbishing the Churchill line to accommodate conventional hopper cars. The results show that none of the commodity schemes considered could be handled through Churchill on an economic basis at present. This is true under all scenarios for ocean freight rates. The commodity scheme with the smallest potential loss is the movement of sulphur to Europe and the USSR and potash to Brazil with a full year's shipment of potash, estimated to be between $1.48 per tonne and $3.55 per tonne more expensive than handling these movements through Vancouver. The most uneconomic movement considered, shipping 72,500 tonnes per year of potash to Brazil, would result in a greater expenditure of about $30 per tonne relative to movement via Vancouver. For most of the other schemes considered, movement through Churchill would be in the order of $5 to $12 per tonne more expensive than movement through Vancouver.

It should be pointed out that, while these costs include (for those options requiring the movement of year round shipment volumes through the Port of Churchill) the increased interest cost of carrying inventory because of the relatively short Churchill shipping season, they do not include any costs for the physical storage of these increased inventories. The potential impacts of a longer Churchill season (e.g. 17 weeks rather than 12 weeks) on the inventory carrying costs were investigated. The potential reduction in interest costs on additional inventory with the longer Churchill season, on a per tonne basis, was found to be less than the cost disadvantage via Churchill in all cases. Therefore, a longer season would not result in overcoming the estimated cost disadvantages of Churchill for any of the schemes.

6. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Essentially the conclusions of this study are negative in that no commodity was found to be more economic as a movement through the Port of Churchill than through existing export or import channels (Vancouver in most cases) when all costs were taken into account, including:

- expected railway rates for the movement of bulk commodities;
- railway car ownership costs;
- additional Churchill railway line costs needed to upgrade the line to accept conventional rail cars;
- actual terminal charges at Vancouver and estimated terminal charges at Churchill;
- ocean freight rates.

Of all the potential movements through Churchill, the one that comes closest to being economic is a combination of the movement of sulphur from Alberta to Europe and to the USSR during the Churchill navigation season, with potash moving from Saskatchewan to Brazil in year-round quantities by stockpiling either at the mine or at Churchill.

It should be noted, however, that in this comparison, although the interest charges of carrying year round inventory for the potash have been included in the comparison, the actual physical storage costs have not.

If the investment for refurbishment of the Churchill line to accept standard railway hopper cars is excluded from the equation, then in two of the three freight rate scenarios the Churchill route would appear to be marginally economic for this movement. This is a very tenuous conclusion, however, based as it is on a number of assumptions favourable to Churchill including:

- this movement would not be charged any of the cost of upgrading the line;
- railway bulk freight rates on the Churchill route can be lowered to a level similar to those on other, main line routes to Vancouver;
- no additional physical storage costs need to be included for the storage of potash beyond those required for the transfer between rail and vessel;
- a rate of return of 11% would be sufficient for the terminal facilities. This before tax rate of return is comparable to those required for public investments but is probably insufficient for private investment in facilities.

All in all, therefore, specific steps for new investment in Churchill are not justified at this time. Such investment could, of course, become justified at some point in the future due to new technology, the development of new commodity movements to/from points located relatively near Churchill and/or major changes in the volumes and origin/destination patterns of existing bulk commodity movements.

Recommendations of the Study Team

Based upon these findings, the study team makes the following recommendations:

1. The various shippers of bulk materials in Western Canada, particularly those of sulphur and potash, should be kept informed of the potential of the Port of Churchill for their use. They should be encouraged to investigate alternative schemes for handling bulk materials through this Port in the light of changing circumstances.

2. New developments in commodity movements should be monitored in order to determine if there are major changes in the volume or origin/destination patterns of commodity movements (such as increased sulphur volumes to Europe) that might improve the competitiveness of Churchill or if there are new commodity movements which might be developing which potentially could move through the Port of Churchill. Examples of the latter are the development of the forest industry in Northern Manitoba and the construction of an aluminum smelter in Manitoba, particularly if it is located in Northern Manitoba. With regard to the proposed aluminum smelter, it should be noted that the Federal and Manitoba Governments have recently initiated a study of the transportation requirements of such a development.

3. Results of this study should be circulated to the various industries and their comments solicited.

4. The review of the changes in the environment that might lead to a more fruitful use of Churchill should be made at least once every three years. It would be desirable that these reviews be conducted jointly by the Province of Manitoba and the Government of Canada. This review would, of course, take into account any changes in government policy and funding regarding Churchill and its rail line, as discussed more fully in the Study D report.

5. As noted earlier, if results of a parallel project under the Canada-Manitoba Subsidiary Agreement on Churchill indicate that the economics of using articulated hopper cars on the Churchill line versus refurbishing the line to take conventional hopper cars are about equal, consideration should be given to the line refurbishment option since this would better leave open the option of future movement of additional commodities through the Port of Churchill.

The Province of Manitoba may wish to consider setting up a special group , either on its own or in cooperation with the Government of the Northwest Territories, to facilitate and encourage Arctic resupply activities through the Port of Churchill, as discussed more fully in the Study C report. If this course of action is followed, the above monitoring and "marketing" activities regarding future use of the Port for additional commodities could also be taken on by the same group or corporation.

1. INTRODUCTION

This study is one of four that were commissioned by the Government of Canada and the Government of Manitoba to study the future of the Port of Churchill. The four studies are:

- Study A: Season Extension;
- Study B: Additional Commodities;
- Study C: Resupply Operations;
- Study D: Grain Shipping Costs.

1.1 PURPOSE OF STUDY

At present the Port of Churchill is used mainly for two functions:

- the export of Canadian grain;
- the resupply of Arctic communities, mostly in the Northwestern section of Hudson Bay.

In the past other cargoes have used the Port of Churchill. Some sulphur was exported during the 1970's. During earlier years, wines and liquors and other general commodities were imported by ships coming to Churchill to handle export grain.

The purpose of this study is to examine the potential for utilizing the Port of Churchill for a broader range of export and import commodities than are handled today. The methodology used was to develop a long list of potential commodities and then to examine each commodity in turn to see if there is any economic benefit in utilizing the Port of Churchill. In doing this various combinations of commodities were also examined.

1.2 STRUCTURE OF THE REPORT

Chapter 2 develops a list of potential commodities that might move through the Port of Churchill based upon both existing commodity movements and the identification of potential future commodities. In Chapter 3, the commodities in the resulting list are analyzed with respect to their potential for movement through Churchill. For the most promising commodities, a cost analysis is prepared which compares the Churchill route with other potential routes for the commodity, excluding costs for handling the additional commodities at Churchill and costs that might be associated with the need to refurbish the Churchill line to accommodate large rail cars. Expected handling costs at Churchill are examined in Chapter 4 and a full cost analysis for the remaining candidate commodity movements is performed in Chapter 5. In Chapter 6 the conclusions and recommendations of the study team are presented.

2. CANDIDATE COMMODITIES FOR MOVEMENT THROUGH CHURCHILL

In this chapter a long list is developed of potential candidate commodities that might move through the Port of Churchill. This list is established based on existing commodity movements to and from Western Canada, potential commodities identified in interviews with various agencies and companies, as well as special consideration of a number of commodities that do not currently move to or from Western Canada but which have potential to do so in the future.

2.1 EXISTING COMMODITY MOVEMENTS TO/FROM WESTERN CANADA

The first step in the development of a long list of potential commodities for movement through Churchill was to look at current commodity movements to and from Western Canada. The major commodity movements identified have been categorized according to rail shipment and port handling volumes in Exhibits 2.1 and 2.2, which present information for exports and imports respectively. The movements shown in these exhibits are for 1983 and have been derived from the Statistics Canada publications International Seaborne Shipping Commodity Statistics (Catalogue No. 54-209) and Railway Transport (Catalogue No. 52-214). The commodities shown are only those for which at least 50,000 tonnes per year is handled at West Coast mainland ports or Thunder Bay. Only these ports are considered on the assumption that exports and imports loaded or unloaded at St. Lawrence and East Coast ports are relatively unlikely to have originated in or be destined for Western Canada. Special investigation has been made to identify any export commodities which might be carried by laker from Thunder Bay for trans-shipment to an ocean vessel at a lower St. Lawrence port.

Commodities to be included in the long list of potential commodities for movement through Churchill were then identified by looking in more detail at the origins/destinations of commodities moving to/from West

EXHIBIT 2.1

1983 WESTERN CANADIAN COMMODITY MOVEMENTS - EXPORTS

(tonnes)

COMMODITY	RAIL SHIPMENTS FROM PRAIRIES TO MARINE EXPORT	TOTAL LOADED TO ATLANTIC PORTS FROM: Western Mainland Ports	Thunder Bay	Total	TOTAL LOADED TO ALL PORTS FROM WMP,TB	% LOADED TO ATL. PORTS	TOTAL LOADED AT CAN. PORTS TO ALL PORTS
COAL	5,270,092	1,624,136	0	1,624,136	15,592,995	10.4	16,902,370
SULPHUR	4,190,944	2,913,873	0	2,913,873	4,687,191	62.2	4,687,209
POTASH*	4,827,691	424,175	36,287	460,462	4,525,561	10.2	4,659,250
LUMBER	65	1,367,164	0	1,367,164	2,489,102	54.9	5,240,556
OTHER CHEMICALS	0	464,083	0	464,083	2,017,247	23.0	3,321,183
WOOD PULP	107,721	788,115	0	788,115	1,739,175	45.3	3,745,413
PULPOOD	0	60	0	60	1,615,441	0.0	1,759,585
LOGS AND BOLTS	0	4,275	0	4,275	1,249,185	0.3	1,559,075
COPPER ORES, CONC, SCRAP	-	15,357	0	15,357	1,126,330	1.4	1,142,248
CRUDE PETROLEUM	0	108,986	0	108,986	511,358	21.3	517,290
NEWSPRINT	60	45,057	0	45,057	427,566	10.5	2,660,902
OTHER PAPER & PAPERBOARD	0	203,638	0	203,638	355,904	57.2	564,631
OTHER PETROLEUM/COAL PRODUCTS	0	46	0	46	338,462	0.0	376,777
OTHER WASTE & SCRAP	0	238	0	238	328,642	0.1	360,452
FUEL OIL	0	30,705	0	30,705	296,896	10.3	1,829,947
NON-FERROU METALS	-	46,742	0	46,742	274,424	17.0	806,036
COKE OF PETROLEUM/COAL	13,240	146,535	0	146,535	230,568	63.6	414,853
OILS,FATS,WAXES	0	6,600	0	6,600	211,249	3.1	402,723
OTHER WOOD FABRICATED MAT	0	143,901	0	143,901	150,602	95.6	212,622
NICKEL-COPPER ORES	220,861	15,722	0	15,722	113,365	13.9	1,234,281
CEMENT	0	0	0	0	95,742	0.0	1,051,478
LIMESTONE	10,795	0	0	0	94,130	0.0	1,690,721
UNMFT. ASBESTOS	0	42,751	0	42,751	76,016	56.2	648,320
LEAD ORES, CONC. SCRAP	83,728	23,808	0	23,808	73,614	32.3	350,835
TEXTILES/RELATED FIBRES	0	0	0	0	61,804	0.0	86,443
FERITLIZERS	73,844	24,184	0	24,184	55,765	43.4	83,536

* Rail Shipments include destinations in Ontario and B.C.

EXHIBIT 2.1 (Cont'd)

1983 WESTERN CANADIAN COMMODITY MOVEMENTS - EXPORTS
(tonnes)

COMMODITY	RAIL SHIPMENTS FROM PRAIRIES TO MARINE EXPORT	TOTAL LOADED TO ATLANTIC PORTS FROM: Western Mainland Ports	Thunder Bay	Total	TOTAL LOADED TO ALL PORTS FROM WMP,TB	% LOADED TO ATL. PORTS	TOTAL LOADED AT CAN. PORTS TO ALL PORTS
WHEAT	22,822,128	624,389	94,000	718,389	8,917,090	8.1	22,675,399
BARLEY	6,425,226	399,897	208,741	608,638	2,396,064	25.4	5,722,694
RAPESEED	1,319,767	48,190	87,500	135,690	1,260,779	10.8	1,261,593
FODDER & FEED	2,217,700	70,450	305,345	375,795	951,154	39.5	1,024,450
RYE	596,542	4,019	84,755	295,546	504,203	58.6	541,003
FLAXSEED	483,347	20,786	291,527	105,541	427,436	24.7	427,802
OTHER CEREAL GRAIN PRODUCTS	-	910	73,998	74,908	296,133	25.3	557,895
OATS	270,490	1,515	24,408	25,923	100,875	25.7	109,406
CORN	239	0	0	0	99	0.0	1,498,146

EXHIBIT 2.2

1983 WESTERN CANADIAN COMMODITY MOVEMENTS - IMPORTS
(tonnes)

COMMODITY	RAIL SHIPMENTS TO PRAIRIES FROM MARINE IMPORT	TOTAL UNLOADED FROM ATLANTIC PORTS AT			TOTAL UN-LOADED FROM ALL PORTS AT WMP,TB	% UNLOADED FROM ATL. PORTS	TOTAL UNLOADED AT CAN. PORTS FROM ALL PORTS
		Western Mainland Ports	Thunder Bay	Total			
SAND & GRAVEL	0	0	0	0	702,751	0.0	1,040,504
PHOSPHATE ROCK	149,125	673,779	0	673,779	673,779	100.0	1,317,237
ALUMINUM ORES, CONC.	0	3,976	0	3,976	511,168	0.8	3,561,112
SALT	350	318,848	0	318,848	408,868	78.0	741,470
TRANSPORT/COMM EQUIP	-	5,874	0	5,874	262,609	2.2	482,737
OTHER IRON & STEEL	0	91,954	0	91,954	228,818	40.2	662,035
PLATE/SHEET STEEL	-	31,607	2,243	33,850	121,787	27.8	272,898
SUGAR	2,493	536	0	536	105,962	0.5	1,098,347
OTHER CHEMICALS	0	38,387	0	38,387	100,596	38.2	1,320,633
FUEL OIL	0	7,092	0	7,092	95,990	7.4	1,851,282
COKE OF PETROLEUM/COAL	-	20,850	0	20,850	80,877	25.8	958,263
OTHER NON-METALLIC MINERALS	-	15,204	0	15,204	68,028	22.3	241,933
BEVERAGES	0	53,825	0	53,825	58,945	91.3	416,047
GYPSUM	0	54,824	0	54,824	54,824	100.0	104,599
FRUIT & PREPARATIONS	-	11,493	0	11,493	53,955	21.3	196,389

Coast mainland ports and Thunder Bay. It was taken as a premise, based on the geographic location of Churchill and its existing destinations for export grain, that for a commodity to be eligible to be moved through the Port of Churchill it must originate or be destined from/to an Atlantic port which includes Europe, the Mediterranean, Western Africa, Eastern South America and the U.S. East Coast. (It is apparent that shipments from Churchill to/from Asian nations would be uneconomic relative to West Coast ports.)

Based on the above considerations, potential movements to be included in the long list were identified using both of the following two criteria:

- the commodity must move to/from West Coast mainland ports or Thunder Bay from/to Atlantic ports in sufficient quantities (over 25,000 tonnes annually);
- the product must move to/from the Prairie provinces from/to marine import/export by rail in sufficient quantities (over 25,000 tonnes annually); this assumes that any export/import commodities moving from/to the Prairies in significant volumes by truck and air are unlikely to shift to movement by rail to/from Churchill.

The commodity must fulfill both of these requirements to be included in the long list. The 25,000 tonne limit used in the above criteria represents one full ship load of movement for typical vessels using Churchill. Commodities with annual movement volumes of less than 25,000 tonnes, therefore, would move in one ship load or just a few partial ship load quantities each year. Given the short navigation season at Churchill, it is probable that Churchill would not capture all of the movements of a particular commodity and therefore the total volume available would be less than one ship load. Because Churchill does not currently serve as wide a range of overseas destination ports as do Vancouver and Thunder Bay, opportunities for consolidating partial ship load quantities into a mixed ship load movement are more limited at Churchill.

Exhibit 2.3 shows the export and import commodities, along with their movement volumes, that meet these requirements. They are:

Exports:

- wheat (including durum);
- barley;
- rapeseed;
- fodder and feed;
- rye;
- flaxseed;
- sulphur;
- coal;
- wood pulp;
- potash.

Imports:

- phosphate rock.

A review of the exhibits shows that only potash and grains are moved from the Port of Thunder Bay to Atlantic ports. The remainder of the products move to the Atlantic ports via Vancouver and other B.C. Mainland ports.

There are also some discrepancies in the Statistics Canada information that should be noted. The first is that, for the grain exports, the total loaded at all Canadian ports to all ports is often smaller than the amount loaded from the Prairies to "marine export". In discussions with the study team a representative of Statistics Canada stated that the discrepancy may be caused by different sources of information and by changing grain storage volumes at the terminal elevators. Statistics Canada felt that the port statistics were more reliable since these had been checked with the Canadian Wheat Board. The other statistics are from the railways who attach an import, export, domestic (IED) code to the waybill which is used to classify shipments directly. In some cases the destination stated on the waybill is not always the realized destination of the product and therefore these rail movement statistics may not be entirely accurate.

EXHIBIT 2.3

POTENTIAL COMMODITY MOVMENTS THROUGH CHURCHILL - BASED ON VOLUME
(1983 tonnes)

	COMMODITY	RAIL SHIPMENTS FROM PRAIRIES TO MARINE EXPORT	TOTAL LOADED TO ATLANTIC PORTS FROM:			TOTAL LOADED TO ALL PORTS FROM WMP,TB	% LOADED TO ATL. PORTS	TOTAL LOADED AT CAN. PORTS TO ALL PORTS
			Western Mainland Ports	Thunder Bay	Total			
EXPORTS	SULPHUR	4,190,944	2,913,873	0	2,913,873	4,687,191	62.2	4,687,209
	COAL	5,270,092	1,624,136	0	1,624,136	15,592,995	10.4	16,902,370
	WOOD PULP	107,721	788,115	0	788,115	1,739,175	45.3	3,745,413
	POTASH*	4,827,691	424,175	36,287	460,462	4,525,561	10.2	4,659,250
	WHEAT	22,822,128	624,389	94,000	718,389	8,917,090	8.1	22,675,399
	BARLEY	6,425,226	399,897	208,741	608,638	2,396,064	25.4	5,722,694
	FODDER & FEED	2,217,700	70,450	305,345	375,795	951,154	39.5	1,024,450
	FLAXSEED	483,347	20,786	291,527	312,313	427,436	73.1	427,802
	RAPESEED	1,319,767	48,190	87,500	135,690	1,260,779	10.8	1,261,593
IMPORTS	PHOSPHATE ROCK	149,125	673,779	0	673,779	673,779	100.0	1,317,237

* Rail Shipments include destinations in Ontario and B.C.

2.2 FUTURE COMMODITIES

Another source of information used in the development of a long list of commodities other than actual movement volumes was through personal and telephone contacts with relevant government agencies in order to identify commodities that might move in the future but do not move in significant quantities today. Economic development agencies in the three Prairie provinces were contacted as well as staff of the Department of Regional Industrial Expansion (DRIE) in Ottawa and all of its Prairie regional offices. Other persons interviewed included representatives of the Port Churchill Development Board, major oil companies, grain and other resource companies, etc. These discussions identified, not only those commodities that currently move through Western Canada as confirmed through the volume analysis described earlier, but in addition some potential commodity movements that may occur in the future. The list of the latter group includes:

- fertilizers and fertilizer ingredients including those that are ammonia based and urea based. Since urea is produced in the USSR, it may be possible to use it as a backhaul for products moving out of North America to the USSR;
- alumina inbound and aluminum products outbound, if a proposed smelter in Manitoba is built;
- forest products, as there is currently a large amount of unutilized forest resources in Northern Manitoba whose products if exploited might be exported through the Port of Churchill;
- farm machinery and implements both inbound and outbound;
- Arctic ores. There are a number of potential mineral producing sites in the Eastern Arctic from which ores may be moved by vessel to the Port of Churchill and then possibly by rail to smelters in Manitoba;
- Arctic oil;

- North Dakota grains. The Province of Manitoba has had some discussion with North Dakota with regard to moving grains through the Port of Churchill and some analysis of the relative costs involved has been made by staff of North Dakota State University;
- liquor imports from Northwestern and Eastern Europe.

This list of future potential commodities was then added to the list of potential commodities based solely on current movements through Western Canada to give a long list of potential commodities. In the next chapter, each of the commodities in this long list is examined as to its relative potential for moving through the Port of Churchill.

3. ANALYSIS OF POTENTIAL COMMODITIES

In this chapter the various commodities identified as having some possibility of moving through the Port of Churchill were examined in terms of their movement characteristics. Based upon this examination some commodities were then removed from further consideration. A comparison of the cost of moving the product through Churchill with the costs for other potential routes was then performed (described in Section 3.2) for the resulting short list of commodities.

3.1 FIRST SCREENING

Each commodity identified in the long list of potential commodities for movement through Churchill was examined with respect to its movement patterns and other characteristics in order to determine whether its movement through Churchill should be seen as potentially economic and therefore whether the commodity should be subjected to a more detailed economic analysis, provided in the second half of this chapter.

3.1.1 Board Grains

The benefits (total freight rate savings from origin to destination) and costs of the movement of grain by the Canadian Wheat Board (CWB) currently shipped through the Port of Churchill are analyzed in considerable detail in Study D of this series of studies. Therefore, this analysis is not repeated here.

Essentially the conclusions of Study D are that the movement of grain to Atlantic destinations through the Port of Churchill will bring about net cost savings in the 1990's compared to the movement of the same grain through Thunder Bay, the alternative route for most of this grain, provided that the line-related costs of the CN line to Churchill are borne by the Government of Canada rather than by grain shippers (because it is assumed that the line would remain open for other reasons even if no grain were being moved through the port) and provided that Churchill grain throughputs exceed about 600,000 tonnes per year.

Thus, Study D concludes that the decision on the movement of grain through the Port of Churchill must follow a decision on the future of the rail line to Churchill and the treatment of the fixed costs of this line, and that movement of grain through Churchill in the 1990's will be economically competitive with movement through Thunder Bay only if it is done on a sufficient scale.

3.1.2 Non-Board Grains

Non-Board grains are those for which the CWB is not responsible for export. These grains are marketed by private companies and cooperatives. The major non-Board grains are rapeseed (canola), rye and flaxseed.

For reasons explained in the Study D report, the Churchill and Thunder Bay/St. Lawrence routes act as alternatives for the movement of grain from the central Prairies to Atlantic destinations. No non-Board grains currently move through Churchill. The volumes of the major non-Board grains exported from Thunder Bay and the St. Lawrence for the last two crop years are as follows:

Exports from Thunder Bay/St. Lawrence
(tonnes)

	1984/85	1983/84
Rapeseed	27,000	85,000
Rye	13,000	81,000
Flaxseed	326,000	333,000

Source: Statistical Handbook 85, Canada Grains Council

Rapeseed and rye can be seen to have shipment levels which are too small to be regarded as potential movements through Churchill other than under exceptional circumstances. Flaxseed has a different problem; only a relatively small proportion is grown in the area of the Prairies closest to Churchill. For example in 1984, a total of 693,000 tonnes was produced but only 166,000 tonnes in the areas adjacent to the Churchill route (Crop Districts 5b, 6b, 7a, 7b, 8a, 8b, 9a and 9b in Saskatchewan and 5 in Manitoba) which comprise the Churchill rail rate advantage area described in Chapter 3 of Study D. More information on grain volumes is provided in Appendix A. Less than half of the flaxseed grown is exported. Given that Churchill is open only three months of the year the potential volume of exports can be seen to be fairly low. However, if it is worthwhile to use the Port of Churchill for Board grains, the same economics will apply to the various types of non-Board grains if the shipper can put together a ship load for movement through Churchill. The fact that non-Board grains would move in such small quantities indicates that inventories of these grains could not be economically kept at Churchill. Grain would have to be moved from the Prairies to meet a specific ship. The quantities moved and the grades would therefore have to match the requirements of a particular order.

There are also two institutional constraints. One is that the elevator in Churchill is owned by the Government of Canada through Ports Canada rather than by one of the major private grain companies or cooperatives. This may give the grain companies less incentive to sell through the Port of Churchill. However, the elevator is a public terminal and will accept any grain for storage and shipment. The second institutional constraint is that Churchill is not a delivery point for the futures market and this restricts its use.

While under particular circumstances it may be worthwhile to export non-Board grains through Churchill, none of the grains examined appear to be promising as candidate commodities for regular movement through the Port. None of the grain companies contacted saw Churchill as a viable port of export for non-Board grains. These grains were therefore dropped from the list of candidate commodities.

3.1.3 Sulphur

Sulphur is a major Canadian export commodity. Canada is third in the world in sulphur production, after the United States and the USSR, and before Poland. In 1983 Canada exported over 4.7 million tonnes of sulphur by ship throughout the world, all of it through the Port of Vancouver, with a further 1.0 million tonnes shipped by rail to the U.S. Of the 4.7 million tonnes exported through Vancouver, almost 900,000 tonnes was destined to European destinations, 745,000 tonnes to West African and North African ports and 1,360,000 tonnes to Eastern South American and Central American ports.

The levels of sulphur exports out of the Port of Vancouver over the last six years are shown in the following table:

Sulphur Exports - Port of Vancouver

Year	Metric Tonnes (Thousands)
1985	6,123
1984	5,558
1983	4,485
1982	4,972
1981	5,515
1980	5,112

Source: Vancouver Port Corporation statistics.

Sulphur production and consumption do not exhibit seasonal patterns, sulphur being produced as a by-product of other industries and being used in various industrial processes. Sulphur is normally moved in bulk, in unit trains on land and in shipload or half-shipload lots on marine routes.

In Canada, sulphur is produced mainly by the refining of sour natural gas. In addition, some elemental sulphur is produced as a by-product of the refining of oil. Due to the concentration of sour gas plants in Alberta, almost 90 percent of all sulphur exported from Canada is produced in Alberta. Recently sulphur production has been declining for two main reasons:

- sour gas pools have been generally replaced by sweeter gas pools;
- natural gas production and sales have been stagnant since 1973 (although this may change with the National Energy Board's approval in 1985 of additional gas sales to the U.S.).

Production of sulphur in Alberta, however, exceeded sales during the 1970's and as a result inventories accumulated during that period. These are expected to be depleted in the late 1980's or early 1990's unless gas production in Canada increases substantially or high sulphur gas fields in Southwestern Alberta are developed. Additional details on Canadian sulphur production and exports are given in Appendix A.

In the 1970's, one sulphur shipper, Amoco, did in fact ship sulphur through Churchill when it could not achieve sufficient capacity through the Port of Vancouver. Due to weight restrictions on the Churchill line, conventional gondola cars could not be used and the sulphur was shipped in small, wooden bottom gondola cars each loaded with about 50 tonnes of product. According to a company official it stopped this movement because capacity became available in Vancouver, CN raised the rail freight rates and it was necessary to rent expensive material handling equipment from Winnipeg. Current discussions with Amoco and other sulphur shippers did not indicate any desire to investigate the use of the Port of Churchill. They appear to be satisfied with their current export channels through Vancouver.

In spite of the current lack of interest expressed by shippers of sulphur in using Churchill it was decided, based on the existing large export volumes of sulphur to Atlantic destinations, to subject a potential sulphur movement through Churchill to a more detailed cost analysis which is included in the second section of this chapter.

3.1.4 Coal

Alberta's coal production has more than doubled during the past decade. About one-third of it is bituminous, of which about 60 percent is exported. During the past five years, exports of Alberta coal have fluctuated somewhat as shown in the following table.

Exports of Alberta Coal

Year	Exports (Thousands of Tonnes)
1984	4,835
1983	5,116
1982	5,265
1981	4,139
1980	4,711

Source: Alberta Government

Most of the exports move to the Pacific Rim countries of Japan and South Korea, but in 1984 over 750,000 tonnes were exported to West Germany, France, Benelux and Brazil. While Alberta exports of coal have been fluctuating, Canadian coal exports in total have increased over 50 percent in the last three years with some of the increase attributable to Atlantic destinations. This suggests that Alberta may be able to increase its exports to these countries with one possibility being that some coal might be shipped through Churchill. However, international coal prices are quite depressed at the present time because of large increases in production capacity in several countries, including Canada. New large coal production facilities in Canada are therefore not expected for several years. There is no seasonality in the production of coal and very little in its consumption, being used largely in industrial processes. Additional details on coal production and exports are provided in Appendix A.

Coal is usually moved in unit trains in large open hopper cars which probably cannot currently be used on the Churchill line due to instability of the rail roadbed and a resulting tendency for hopper cars (because of their long wheelbase and particularly when empty) to be derailed through exaggerated swaying at resonant frequencies. Therefore for coal to be moved through the Port of Churchill it would be necessary to upgrade the line to accommodate these heavy cars or to move the coal in a specially designed articulated hopper that can be used on the line. CN has developed and is currently testing a prototype articulated grain hopper car for use on the Churchill line and light carrying capacity branch lines; this could be further developed to produce a design suitable for coal shipment.

Coal now moves mostly in large vessels (50,000 tonnes or more) which, to be economic, require rapid loading facilities. Essentially all coal is now exported through specialized terminals adjacent to Vancouver (Roberts Bank) and Prince Rupert (Ridley Island). The movement of coal through the Port of Churchill would require terminal expenditures for new storage and loading facilities. However, the large volumes of coal moving to Atlantic destinations make it a possible commodity for movement through Churchill; therefore analyses of the relative costs for moving coal through Churchill compared to other routes are provided later in this chapter.

3.1.5 Potash

Most of the potash exported from Canada is mined in Saskatchewan in Rocanville, Esterhazy, and near Saskatoon and Regina although two new mines are being developed and have started production in New Brunswick. Almost 75 percent of the potash produced in Canada is exported, to the U.S. by rail and lake vessel and to other countries by ocean ship. Almost all of the Saskatchewan potash exported overseas moves through Vancouver, while Thunder Bay handles about 1 million tonnes annually going to U.S. Great Lakes ports. The following shows the levels of potash exports from the Port of Vancouver over the last six years:

Potash Exports - Port of Vancouver

Year	Exports (Thousands of Tonnes)
1985	3,028
1984	4,065
1983	3,206
1982	2,558
1981	2,955
1980	3,448

Source: Vancouver Port Corporation Statistics

Although potash exports have fluctuated during the period, the last three years (including 1985) have seen a substantial increase over the low levels of 1982. Officials of the cooperative of the Saskatchewan potash exporting companies, Canpotex, see some room for growth in exports to Pacific rim countries, including Japan, China and India but are less optimistic about possible exports to Atlantic destinations because of competition from other overseas suppliers such as the Soviet Union and East Germany and from the new mines now starting to export from New Brunswick (Saint John).

Approximately 10 percent (460,000 tonnes) of the potash exported overseas from Canada moves to Atlantic ports, with the major destinations being Brazil, South Africa and U.S. Atlantic and Gulf ports.

Potash usage is seasonal, normally being applied in temperate countries in the Spring or Fall. However, this seasonality of demand is blurred by the need for importing countries to have inventories of potash (in order to blend it with other fertilizer ingredients), by the inclusion of tropical and Southern Hemisphere countries in the destinations and by the pricing practices of the companies who wish to have a more even distribution of sales over the year to match production patterns. Shipments to Brazil exhibit a slight peak in the June to September period.

Currently, rail movement of potash for export through Vancouver is handled quite efficiently by Canpotex. Potash is moved in unit trains of covered hopper cars which cannot be used on the Churchill line for the reasons stated above. Therefore, use of the special articulated hopper car recently developed by CN or upgrading of the line to accommodate conventional hopper cars would be r equired to move potash to Churchill. The movement of potash through the Port of Churchill would also require terminal expenditures to accommodate this commodity because it requires covered storage. However, potash is the only major bulk commodity (except grain) produced or consumed in the part of the Prairies which is closer to Churchill than to the Pacific Coast. Therefore, it was decided to analyze the costs of moving this commodity on alternative routes, comparing Churchill with Vancouver and Thunder Bay.

3.1.6 Wood Pulp and Wood Chips

The movement of wood pulp from the Prairies for marine export is very small but has shown an upward trend over the last five years. The movements of wood pulp are shown below by Prairie province for this period:

Wood Pulp - Prairies to Marine Export
(tonnes)

Year	Manitoba	Saskatchewan	Alberta	Total
1983	0	76,916	30,805	107,721
1982	0	44,161	22,235	66,396
1981	874	55,184	25,251	81,309
1980	408	50,814	23,692	74,914
1979	0	31,380	9,466	40,846

Source: Statistics Canada, Railway Transport (Catalogue No. 52-214), 1983.

These exports are about evenly split between Pacific Rim and Northwest European destinations.

Due to its short shipping season, Churchill could likely capture only a percentage of these movements. In addition they are split between the provinces such that a movement from one province would barely represent a full shipload of wood pulp over a whole year. Interviews with the industry confirmed that wood pulp moves in relatively small shipments, requiring a port handling a wide variety of commodities with a variety of shipping services including container services. Because of these considerations the movement of wood pulp through Churchill does not look promising at this time, and wood pulp has been eliminated from the list of potential commodities.

In 1983, approximately 430,000 tonnes of wood chips were produced at Alberta sawmills. Almost all of this volume, however, is currently shipped to two plants in the province where it is converted to pulp. This pattern of shipment is likely to continue in the future and therefore there is little potential that unprocessed wood chips from Alberta might be exported through Churchill.

3.1.7 Other Forest Products

Today there are approximately 1 million cunits (cords per year) of forest resources in Northern Manitoba which are not being utilized. Approximately half of these are unleased in the Hayes River area and the other half is in the Nelson River area. The latter is currently leased to ManFor, a crown corporation based in The Pas, but is currently surplus to existing requirements. The main product of the ManFor operation is unbleached paper which is shipped in rolls. One million cunits would produce approximately 1 million tonnes of paper or 500,000 tonnes of pulp per year.

The main market for ManFor is the United States; most of their product is sold in the West and Mid-West, moving mostly by rail although some moves by truck. The product moves in small shipments, typically in carload lots. Because of the relatively high value of the product, currently about $550/tonne, large inventories are not desirable. Hence use of Churchill by ManFor is unlikely because stockpiling would be required to deal with the short Churchill season and because the rail and truck routes to the U.S. market are much faster than marine movement through Churchill.

Currently there is a surplus of pulp and paper productive capacity and it is unlikely that a large new mill will be developed in Northern Manitoba over the next few years. Therefore, this industry does not appear to be a prospect for movement of product through Churchill over the short term. Over the long term it is possible and probable that the forest resources of Northern Manitoba will be further developed, although even then it is questionable that export through Churchill will be economic, given the movement characteristics of the products. Additional details on volumes of Canadian exports and export markets of forest products are provided in Appendix A.

3.1.8 Phosphate Rock

Phosphate supplies about 50 percent of the total nutrient content of fertilizers used in Canada, although proportions vary according to specific requirements. Commercial phosphates are derived from phosphoric acid which in turn is produced by reacting phosphate rock with sulphuric acid. Active phosphate plants in Western Canada are located at Redwater and Calgary, Alberta, and Kimberley and Trail, British Columbia.

Virtually all of the phosphate rock used in Canada is imported from the United States. Of the over 3 million tonnes imported in 1984, 65 percent came from Florida and 35 percent was imported from two western states, Utah and Idaho. Rock from Florida is moved in by ship both to East and West Coast ports and from there by rail to acid plants; some is moved entirely by rail. Phosphate rock from Utah and Idaho moves by rail.

Based on information from Statistics Canada, port statistics and the CTC waybill survey, approximately 300,000 tonnes of phosphate rock is imported from Florida and moved into Alberta through the Port of Vancouver. According to the Canadian Fertilizer Institute the phosphoric acid plants operating now in Alberta, the Esso chemical plant in Redwater and the Western Cooperatives in Calgary, between them use over 1,500,000 tonnes of phosphate rock annually. There are also two plants that are currently idle, one in Fort Saskatchewan and one in Medicine Hat, which together would have annual requirements of 400,000 tonnes if operations were to be resumed. Therefore, when world markets permit full utilization of all existing plants, consumption in Alberta might increase by 30 percent.

The volumes of phosphate rock moving from marine import into Alberta warrant that a cost analysis be made to identify whether it is a potential commodity for movement through the Port of Churchill. However, the rail distance via Churchill as compared to moving via Vancouver is almost double (2,055 km from Churchill versus 1,124 km from Vancouver to Redwater, Alberta), whereas there is only a 15 percent saving on the sea distance

(7,500 km to Churchill versus 8,800 km to Vancouver from Florida). Phosphate rock, however, could be a backhaul for other commodities identified as potential exports through Churchill, although backhaul possibilities through the Port of Churchill are potentially offset by backhaul possibilities to Vancouver. A detailed analysis of the costs of moving phosphate rock through Churchill and alternative ports is included in section 3.2.

3.1.9 Urea and Other Fertilizer Products

Nitrogen provides about 25 percent of the nutrient value supplied by commercial fertilizers; potash and phosphates the remainder. Urea is one of the family of nitrogen based fertilizers, others being ammonia, ammonium nitrate and ammonium sulfate. Ammonia is made by the catalytic reaction of nitrogen from the air and hydrogen stripped from natural gas. Urea is then produced by reacting ammonia and carbon dioxide under pressure.

During the last 15 years there was a major increase in nitrogen and ammonia productive capacity as a result of:

- anticipated population growth and rising expectations, particularly in the third world;
- many nations producing oil and natural gas developed policies to reinvest their wealth from the huge price increases in this product and where possible to emphasize exports of finished products over raw materials.

Both Canada and the USSR expanded their productive capacities beyond domestic demand; Canada is now a net exporter of urea. Exhibit 3.1 shows the volume of imports and exports of urea.

EXHIBIT 3.1

CANADIAN TRADE IN UREA

	Fertilizer Years	
	1983/4	1984/5
	(thousands of tonnes)	
Imports	226	219
Exports	687	1,240

SOURCES OF IMPORTS

	1982	1983	1984
	(thousands of tonnes)		
USA	98	126	134
Western Europe	8	55	116
Other	-	-	11
	106	181	261

DESTINATION OF IMPORTS

	Fertilizer Years	
	1983/4	1984/5
	(thousands of tonnes)	
Urea		
Imports into Eastern Canada	223	219
Imports into Western Canada	3	1
Total	226	220

Source: Statistics Canada

The urea export market for Canada is very unstable. Canada can compete only when the price of urea is high, due to high cost levels including energy prices. For example, between July and October, 1984 there were 375,000 tonnes of urea exported overseas from Canada, whereas in the same period in 1985 only 20,000 tonnes were exported. Main receiving countries of Canadian urea are China, India and Colombia. Exports from Canada originate in Western Canada (all of the urea is manufactured in Alberta), close to the source of natural gas. Although it is possible that some of this urea could move through the Port of Churchill, the market is very unstable and is judged by the study team to be too unstable to warrant the capital expenditures necessary to allow handling of this product at Churchill

Canada currently imports urea into Eastern Canada, the bulk of it from the United States and Western Europe. Imports into Eastern Canada through Churchill would of course not be economic.

Due to the large exports of urea from the USSR, it has been suggested that there is a possibility that it could become a backhaul for products moving from North America to the USSR. Contact was made with representatives from Cargill who have explored the possibility of moving urea through Churchill from Russia. They have looked at this movement particularly for urea destined to the United States, as they currently bring several shiploads a year into Florida from the USSR. Their reasons for rejecting this movement were that the short shipping season at Churchill would require storing the product and the problems associated with the types of cars that could be used on the Churchill line. They did not advance their study to the point of asking CN for rail rate quotes. The Cargill contact also said that in the past there have been some problems with the quality of the product brought in from the USSR which might limit their desire for importing it from this source.

The current trading pattern is that Canadian urea is produced in the West and is used on the Prairies and is exported to the United States by rail and overseas on occasion by vessel through Vancouver, mostly to Pacific Rim countries, while Eastern Canada imports urea from the United States and Western Europe. There is no apparent reason why this trading pattern will not continue, particularly when it is observed that there is considerable excess productive capacity available in Western Canada. Urea was therefore not subjected to a more detailed cost analysis.

Discussions with representatives of the Canadian Fertilizer Institute showed that the only fertilizer materials that are exported overseas in substantial quantities are urea and potash. There is some ammonia sulphate and ammonia phosphate exported overseas but not in quantities that would make development of the Port of Churchill for these products feasible.

Due to current trading patterns of urea and other fertilizer products, all but potash have been ruled out as candidate commodities for movement through the Port of Churchill. No new developments were expected in this field.

3.1.10 Alumina

The construction of an aluminum smelter in Manitoba has been proposed to take advantage of the Province's hydro-electric resources. Due to current low levels of aluminum prices and excess production capacity, it is not expected that this project will become viable until the demand for aluminum increases significantly.

The most recent proposal, made by Alcoa, was for the smelter to be located in Southern Manitoba near Winnipeg. The location was chosen based on two factors: it would be on the major transportation routes and relatively little urban infrastructure would have to be provided by the company. It was planned that the approximately 400,000 tonnes of alumina required annually would be imported through the Port of Vancouver from Australia. Work on this project was suspended because of low aluminum prices. Such a project may be restarted in the future by Alcoa or by other companies when prices improve. Manitoba has the low-cost hydro-electric resources, the key element in smelting aluminum.

Canada currently imports substantial amounts of bauxite and alumina from South America and the West Indies. Therefore it is quite possible that a future aluminum smelter in Manitoba might source its requirements from these areas as well. The movement of this product through Churchill would be attractive in that it could act as a partial backhaul to grain on both the marine and land sides. The same would be true, however, if the alumina were to be brought in through Thunder Bay. Churchill has a limited season length and therefore if the alumina were to be imported entirely through this port a large inventory (averaging about 150,000 tonnes) would be required to handle the smelter requirements over the period of the year when Churchill is closed. Alternatively, another port such as Thunder Bay could be used to handle the alumina while Churchill is closed, but this would appear to be a relatively uneconomic arrangement since it would require the costly duplication of alumina handling facilities at the two ports with neither able to achieve the maximum available economy of scale.

The simplified cost comparison shown below demonstrates that if the smelter were located in Southern Manitoba, Thunder Bay would have a cost advantage over Vancouver and Churchill for the movement of alumina from the West Indies (Jamaica) to the smelter:

Relative Costs of Transportation of Alumina to Southern Manitoba

	$/Tonne		
	Through Vancouver	Through Thunder Bay	Through Churchill
Ocean Freight from West Indies	$16	$24	$21
Additional Inventory Carrying Costs	-	$ 4	$ 9
Rail Transportation (including car costs)	$44	$19	$29
Total	$60	$47	$59

The derivation of the estimates for rail and marine freight rates is described later in this chapter. One observation is that the rail rates described for Churchill may be low because no allowance is made for the special conditions that apply to this line. The additional inventory carrying costs are based on an additional average four and one-half months' supply of alumina being required at Churchill and an additional average two months' supply at Thunder Bay to handle the smelter's requirements during the nine-month and four-month seasonal port closures at Churchill and Thunder Bay respectively, and assuming a value of alumina of $250 per tonne and an annual interest rate of 11 percent.

Since the smelter is currently proposed to be located in Southern Manitoba, the movement of alumina through the Port of Churchill appears to be uneconomic and therefore alumina is not included in the short list of potential commodities for movement through the Port.

If the aluminum smelter were to be located instead in Northern Manitoba, Churchill might become cost competitive with Thunder Bay as the handling port for the alumina, as shown in the simplified cost comparison below (based on rate estimates derived in the same manner as those in the table above):

Relative Costs of Transportation of Alumina to Northern Manitoba (Thompson)

	$/Tonne		
	Through Vancouver	Through Thunder Bay	Through Churchill
Ocean Freight from West Indies	$16	$24	$21
Additional Inventory Carrying Costs	-	$ 4	$ 9
Rail Transportation (including car costs)	$45	$32	$17
Total	$61	$60	$47

The possibility of locating the smelter in Northern Manitoba might perhaps be explored further by the Manitoba Government with various aluminum companies.

It should be noted that a study has recently been commissioned by the federal and Manitoba governments to examine in detail the transportation costs associated with the operation of an aluminum smelter in Manitoba. Only locations in Southern Manitoba are being examined, as we understand the terms of reference.

If the smelter is built in Manitoba it would produce about 200,000 tonnes of raw aluminum per year. Based upon the current export pattern, less than 15,000 tonnes would be exported abroad. Given the relatively high value of finished aluminum and the likely shipment sizes that it would be moving in, Churchill would not likely be economic for this outbound movement.

3.1.11 Arctic Ores

There are a number of potential mineral producing sites in the Eastern Arctic. The possibility of moving these ores by vessel to the

Port of Churchill and then by rail to the nickel smelter at Thompson and the copper/zinc smelter at Flin Flon has been proposed.

Plans for the development of a nickel mine in Northern Quebec by New Quebec Raglan Mines Ltd. included movement by water through Churchill to Thompson. World nickel prices must increase from current levels before this mine will be developed.

Lead/zinc concentrates currently being produced at the Nanisivik mine on Baffin Island move directly from the mine to smelters in Europe. The Polaris mine developed by Cominco on Little Cornwallis Island is also very successful. However, representatives from the companies felt that there was little chance that the product would be moved through Churchill as the ultimate destination of the products is overseas and it would be uneconomic to bring the ores inland in Canada to refine and then re-export the product.

Other ores which are known to be present in the Hudson Bay/Foxe Basin area are iron ore, uranium and several showings of gold. Iron ore is not likely to be developed in the short term because of the current over-supply in the world market. The uranium prospects in the Eastern Arctic area are over-shadowed by better prospects in other parts of Western Canada, particularly Northern Saskatchewan. It is likely that, because of the low volume and very high value of their product (making inventory holding and the use of slower modes of transport very expensive), most gold mines would ship their product by air.

It is expected that within the next five years there will be no significant new ore developments in the part of the Arctic served by Churchill. In future there will be some new developments; however, discussions with the industry show that it is unlikely that the minerals would move through the Port of Churchill. It is more likely that Churchill would become a resupply point for exploration, development and mining activities. For these reasons, the movement of Arctic ores through the Port of Churchill has been ruled out from consideration for more detailed analysis.

3.1.12 North Dakota Grains

There has been some interest shown by the State of North Dakota in moving products through the Port of Churchill. Discussions with personnel from North Dakota State University (NDSU) Institute in Transportation have confirmed that they have done some analysis on grain movement through Churchill. They found that the most feasible movement was from the northwestern part of the state where mostly wheat is grown. For their cost analysis they assumed that this wheat was moved by truck to Saskatchewan and then by rail to Churchill. A truck movement was used because the railroads of North Dakota were assumed not to want to short-haul the product over the border when it would otherwise be carried by them over greater distances to St. Paul or Duluth and also because of the restriction to boxcars on the Churchill line which the U.S. railroads and elevators do not want to handle. (The NDSU analysis did not consider the possible use of articulated hopper cars for the movement to Churchill nor the possibility that Canadian railways might be able to arrange for through service with one of the North Dakota railroads.) The other grain they looked at was corn which is grown primarily in the southeastern part of the state near Fargo. Substantial movements of corn for feed already occur between the southeastern part of the state and Winnipeg.

The following cost analysis was then prepared by NDSU for products moving from the extreme northwestern part of the state, the central part of the state and the southeastern corner. Three alternative routes to Rotterdam were compared for each origin area:

- by rail to Duluth and through Superior to the St. Lawrence system;
- by rail to Minneapolis/St. Paul and then by barge down the Mississippi to the Gulf;

o by truck to Saskatchewan and then by rail to Churchill.

The following shows the NDSU results which include ocean costs to Rotterdam in U.S. cents per bushel:

Cost Comparison for Grain from North Dakota to Rotterdam

	Route		
Origin	Via Duluth	Minneapolis/ Barge to Gulf	By Rail to Churchill
Southeastern	77	83	139
Central	93	99	148
Extreme Northwestern	116	122	123

The Churchill route was close to being competitive only for movements from the extreme northwestern part of the state. Even then, however, Churchill is still more expensive than the alternative routes.

From the NDSU analysis and through a similar analysis carried out by IBI Group and given in Appendix B which compared similar routes plus the Thunder Bay route, it has been established that Churchill is not currently an economic port for moving any grains to Europe from North Dakota. Even if it were possible that trains carrying corn to Churchill could backhaul urea from the Soviet Union, the Duluth route is still shown to be cheaper on a similar basis and involves the same limited number of handlings of the corn enroute as would be the case through Churchill.

3.1.13 Farm Machinery and Implements

Less than 50,000 tonnes per year of farm machinery and implements currently move from the Prairie provinces to overseas export. We have discussed farm equipment shipments with Versatile Equipment Company in Winnipeg, the major producer of farm equipment in the Prairie provinces.

According to the Versatile spokesman, the great majority of farm machinery and implements produced in the Prairie provinces is shipped within the Prairies or to the Mid-West and Far-West areas of the U.S. There are some overseas exports to Northwest Europe, Africa, Australia and the Persian Gulf area, but these are quite small in terms of tonnage. In a good year, about 50 large tractors are shipped to Northwest Europe. This represents a total annual shipment weight of only 450 tonnes. The equipment exported to Atlantic destinations is typically moved by truck to an East Coast port (Halifax or New York) where it is transferred to Ro-Ro (roll on/roll off) vessels for the trip overseas. The product could alternatively be carried on conventional ocean bulkers using heavy lift cranes to transfer the product from shore to ship, but there is some concern that this method of handling might cause damage to the tractors and other farm machinery if not done carefully. For this reason, Ro-Ro shipping is the preferred method of handling for the ocean movement.

Due to the current very low tonnages of product exported to Atlantic destinations, combined with the frequent need to ship farm machinery going overseas very quickly which often necessitates the use of truck transportation to the port, as well as the impracticality of providing Ro-Ro service at Churchill due to the lack of a road link with originating plants, the export of farm machinery and implements through Churchill does not appear to be feasible at present.

Most of Canada's imports of farm machinery and implements come from the United States. It has been proposed that farm equipment produced in Poland and the USSR could serve as a backhaul to grain exports through Churchill. Since these imports would not likely move in sufficient volumes to justify the installation of handling facilities in Churchill, they were judged to be not economically feasible at present because of the lack of frequent marine services to Churchill and the lack of port facilities.

3.1.14 Arctic Oil

There have been several recent discoveries of oil in commercial quantities in the Canadian Arctic. The major discoveries have been in the Beaufort Sea in the western part of the Arctic. From this area export will likely be via the Bering Strait to Pacific destinations. There have also been discoveries in the central and eastern Arctic, most notably at Bent Horn, whose products might be exported eastward. The question to be addressed is whether this eastward movement might use the Port of Churchill.

Currently Canada exports oil from the West by land to the United States and imports oil by sea into Eastern Canada. Logical markets from the Eastern Arctic therefore might be Eastern Canada and export to the United States or to Europe. Exports to the United States and Europe would not pass through Churchill.

Crude oil will be moved from Bent Horn to a refinery. At present there is over capacity in refineries in Canada. Several have been closed in recent years. It is therefore unlikely that a new refinery will be built to handle Arctic oil if this crude is to be used for domestic consumption. Refineries in Western Canada are connected by pipeline to the Alberta fields and, as there is a net export of crude oil from Western Canada, Arctic oil is unlikely to move to Western Canada. Therefore, the destination of Arctic oil, if moved within Canada, must be existing refineries in Eastern Canada which are all located with direct marine access.

Our conclusion is therefore that Arctic oil is most likely to be moved directly by sea either to Atlantic/St. Lawrence destinations within Canada or to overseas destinations. Because of the distances and directions of Bent Horn and the markets from Churchill, construction of a pipeline from Churchill south to join with the cross-Canada network is not considered to be viable relative to direct movement by sea to a refinery.

3.1.15 Liquor

It has been suggested that liquor from Europe could be imported through Churchill to Saskatchewan and Manitoba as a backhaul to outbound grain shipments. We have discussed this possibility with representatives of the Manitoba Liquor Control Commission and the Saskatchewan Liquor Board.

The following table shows the volumes of liquor (wines and spirits) imported by Saskatchewan from Europe in 1985:

1985 Saskatchewan Liquor Imports from Europe

Country	20 Foot TEUs (Trailer Equivalent Units)	Tonnes
United Kingdom	63	781
France	100	1240
West Germany	91	1128
Italy	90	1116
Scandinavia	5	62
Poland	4	50
U.S.S.R.	2	25
Portugal	9	112
Spain	5	62
Greece	4	50
Total:	373	4626

Source: Saskatchewan Liquor Board

It is seen that total liquor imports into Saskatchewan from Europe are quite small in terms of tonnage. Furthermore, the total volume imported from Belgium, Poland and the U.S.S.R., the nations which have received grain shipments from Churchill on a reasonably regular basis over the past five years, was only 75 tonnes in total, constituting slightly over one boxcar load. Import volumes to Manitoba from these three nations are currently even lower.

Liquor imported into Manitoba and Saskatchewan from Europe currently moves by rail from Montreal, primarily in containers. Because the Port of Churchill currently lacks container handling facilities, liquor imported through Churchill would have to be shipped on pallets rather than containers, presenting increased problems of security against theft and breakages. Non-containerized movements of liquor are not seen as desirable by the liquor control agencies for this reason.

A further problem with importing liquor through Churchill would be the logistical difficulties associated with arranging pick up of the liquor in Europe. The liquor control agencies and the European liquor suppliers would have to be notified in advance of the specific vessels chartered for voyages from Churchill and would have to negotiate with the shipowners for loading the liquor at a European port. Because of the very small volumes involved, it would not pay a shipowner to make a special trip to a port just to pick up this cargo and hence the liquor loading port would have to be the discharge port of the former cargo for the vessel in question (or the discharge port of the Churchill grain if the vessel were immediately making a second trip to Churchill). Because of these logistics requirements, it is conceivable that some of the intended liquor shipments could be missed, resulting in high inventory carrying costs for the liquor agencies and inconvenience to consumers. During the 1950s and 1960s, liquor was brought to Churchill from the U.K. in the vessels of the Dalgleish shipping line. Because this line made many voyages each season to and from Churchill from a set of U.K. ports, a regular arrangement could be made with distillers to deliver the product for shipment to Churchill. Because grain is no longer shipped from Churchill to the U.K. and because a large number of shipowners now serve Churchill each on a less frequent basis, combined with the development of container services at other ports, the import of liquor through Churchill today is not as feasible as it was in the 1950's and 1960's.

Based on the above considerations, we conclude that the movement of imported liquor through the Port of Churchill is not economic.

3.1.16 Summary of First Screening

From the above analysis of the various commodities in the long list of potential commodities for movement through Churchill, it was possible to eliminate many commodities as not showing a great deal of potential for movement through Churchill. A short list of commodities judged to warrant more detailed analysis of costs and handling requirements was then developed based on volume and movement characteristics and the other considerations discussed in this section. This short list includes:

Exports:

- grain
- sulphur;
- coal;
- potash.

Imports:

- phosphate rock.

For sulphur, coal, potash and phosphate rock, the following section provides a comparative cost analysis of moving the product through Churchill versus the alternative ports of Vancouver and/or Thunder Bay. In addition the possibility of combining these commodities in different ways is analyzed. For grains, a detailed cost comparison is made in Study D. Exhibit 3.2 shows for the shortlisted commodities 1983 volumes between the primary origins and destinations in the Prairie provinces and the major Atlantic ports to which each commodity is normally destined.

EXHIBIT 3.2

PRIMARY ORIGINS/DESTINATIONS OF POTENTIAL COMMODITIES FOR MOVEMENT THROUGH CHURCHILL

EXPORTS

PRODUCT	ORIGIN	DESTINATION[1]
Sulphur	Ram River, Alta. Medicine Hat Edmonton	South America (Argentina and Brazil) (612) Northwest Africa (1,034) Northwest Europe (693) USSR (155)
Coal	Central Alberta	Europe (490) South America (Brazil) (277)
Potash	Rocanville, Sask. Esterhazy, Sask. Saskatoon Regina	South America (Brazil) (290)

IMPORTS

PRODUCT	ORIGIN[1]	DESTINATION
Phosphate Rock	Florida (300)	Redwater, Alta. Calgary

1. Bracketed numbers show amounts in thousands of tonnes of product moving in 1983 from/to that origin/destination through Vancouver or Thunder Bay ports to/from the Prairies.

3.2 COST ANALYSIS OF SHORT LISTED COMMODITIES

In this section the economics of the movement of the shortlisted commodities are examined, first each commodity separately and then in combination in order to determine if there are any economies of scale to be achieved by moving them together and sharing facilities.

3.2.1 Cost Analysis for Individual Commodities

This sub-section provides an analysis of the costs associated with moving each of the four potential commodities in the short list (sulphur, coal, potash and phosphate rock) through Churchill as compared to similar movements through the alternative ports of Vancouver and Thunder Bay. The cost comparisons in this sub-section are for movements of a single commodity; combination movements involving the shipment of two or more commodities and with backhauls are considered in sub-section 3.2.2.

The costs developed in this section for moving each commodity include the following components:

- o rail rates, including car costs;
- o terminal handling rates at Vancouver. Terminal costs at Churchill for each additional commodity and combination of commodities are developed in Chapter 4;
- o ocean rates (including port charges).

The cost comparisons presented in this way provide estimates of the maximum per tonne amounts available for terminal handling facilities at Churchill such that movement of the commodity through Churchill would be less expensive than moving it through Vancouver or Thunder Bay. When this maximum allowable Churchill terminal cost turns out to be negative, the commodity movement in question is eliminated as a possible movement through Churchill. Those movements for which the maximum allowable

Churchill terminal costs are positive are examined further in Chapter 5 in light of the corresponding terminal cost estimates of Chapter 4 and additional costs (including the cost for upgrading the Churchill line to accommodate conventional hopper cars) considered in Chapter 5. Below, each of the three movement cost components given in the list above are discussed and the cost comparisons for the individual commodities are presented. 1985 dollars have been used throughout.

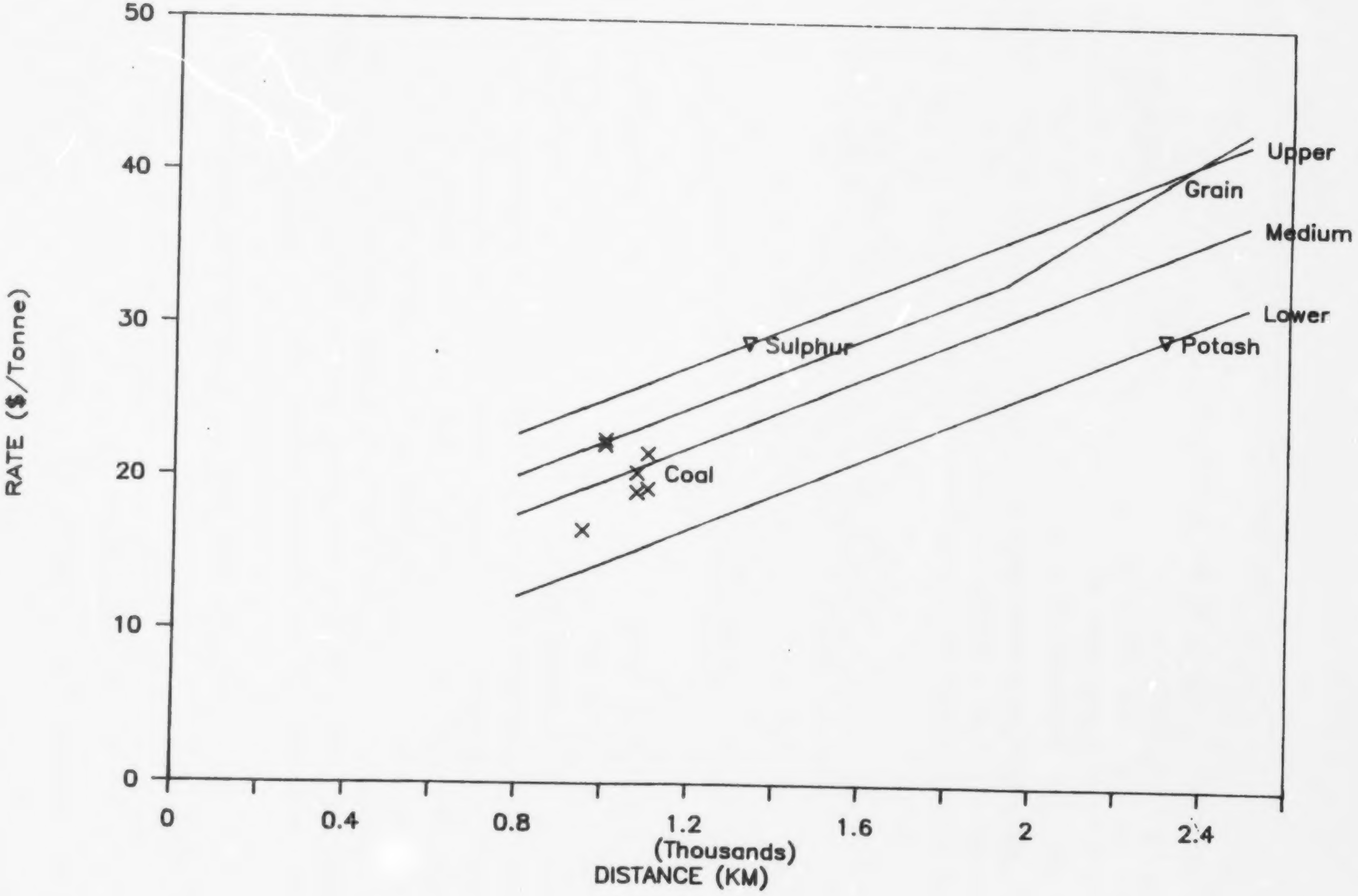
Rail Rates and Car Costs

Rail rates for moving each of the commodities from a typical origin or to a typical destination to/from Churchill, Vancouver and Thunder Bay have been estimated using some known rates for grain, sulphur, coal and potash.

Exhibit 3.3 plots a number of rail rates for bulk materials against distance for sulphur, potash and coal obtained from tariffs and discussions with the respective industries, as well as the line representing the full statutory rates (shipper and Federal Government shares) for grain established by the Western Grain Transportation Act. The sulphur, potash and coal rates shown do not include the costs of rail cars which must be supplied by the shippers. The grain rates only include a very small proportion of car costs as over the last two decades almost all new cars and rehabilitation of old cars have been paid for by agencies other than the railways (Federal Government, CWB, Provincial Governments, etc.). Assuming that the rates for other bulk commodities vary with distance in the same manner as do grain rates over the range of distances considered in our cost comparisons (800 km to 2,000 km), the sulphur and potash rates establish a range of possible rail rates as shown on Exhibit 3.2. The upper and lower bounds of this range were estimated as follows in dollars per tonne with distance expressed in kilometres:

- upper - \$14.34 + (.011 x distance)
- lower - \$4.13 + (.011 x distance)

ESTIMATED RAIL RATES – 1986



Similarly, a medium rail rate has been estimated as:

- medium - \$9.24 + (.011 x distance)

These are generalized rail rates which do not reflect the particular circumstances of individual lines. Specifically they do not reflect the characteristics or rate requirements of the Churchill line. (CN was asked to provide specific rate quotations for the Churchill route but did not do so.) Because of this effect the application of these rates to movements through Churchill does not take into account:

- the need to use special cars or to refurbish the Churchill line because of present instability problems caused by permafrost soil conditions on this route;
- the lack of possibility of exploiting the economies of scale possible on other routes because of large scale movements of many different types of commodities.

Estimates of the car ownership costs have been developed assuming conventional large cars such as hopper or gondola cars. At this time, the Churchill line cannot accommodate this type of car and therefore the line would have to be improved or a more expensive car such as the articulated hopper car now being tested by CN would have to be used (grain currently moves over the line in boxcars only and the sulphur shipped in the 1970's moved in small gondola cars carrying only 50 tonnes each compared to the 91 tonne capacity of conventional gondolas). In Chapter 5, we consider these car-related options and their relative costs in detail in making final comparisons for the potential commodities.

Basic rail car costs were estimated assuming the following rail car characteristics:

- initial cost - \$70,000;
- average life - 30 years;

- interest rate - 11 percent;
- payload - 91 tonnes (fully loaded).

The 11 percent interest rate is lower than a normal commercial before-tax return but has been used in all of the financial analyses in these four Churchill studies, representing the current government interest rate.

The cost per tonne for car ownership is then calculated as the annual cost of the car based on the expected life and interest rate divided by the payload and by the expected number of cycles that the car can make in a year. The number of cycles is estimated as 365 days divided by the number of days required for one return haul (cycle). Cycle times for the various movements have been estimated based on actual cycle times reported by the potash industry for two specific movements as follows:

- Saskatoon to Vancouver (1,750 km): average cycle time = 10 days for 36 cycles per year;
- Edmonton to Vancouver (1,230 km): average cycle time = 8 days for 45 cycles per year.

These two observations of the cycle time associated with a given distance have been taken as reasonably representative of expected operating practices for any bulk commodities loaded/unloaded at a small number (one or two) of origins/destinations and routed over mainlines, and have been used to obtain a function for the number of cycles associated with any distance. For a given distance, no extra time was added for the Churchill route. A straight line drawn between the two observations gives the following equation:

$$\text{number of cycles per year} = 67.25 - .0175 \times \text{distance in km}$$

The car ownership costs are then calculated for a particular commodity movement as:

car ownership costs = $8,052/number of cycles per year/91 tonnes

Terminal Costs

The current terminal charges for movements of potash and sulphur through Vancouver were obtained from personnel in the respective industries. A private port operator was contacted in Vancouver for the coal and phosphate rock rates but his response was that these rates were confidential and negotiated separately for each movement. He did say that phosphate rock had similar rates to potash, while coal rates were slightly lower due to the higher speed at which coal is loaded. Therefore, the phosphate rock rate was assumed to be equal to the known potash rate and the coal rate was set $0.50 per tonne lower than the potash rate. The terminal charges for Vancouver used in the cost comparisons are:

- potash - $4.50 per tonne;
- sulphur - $5.50 per tonne;
- coal - $4.00 per tonne;
- phosphate rock - $4.50 per tonne.

The terminal charges for handling the various bulk commodities at Churchill are discussed in Chapter 4 which considers various handling schemes for inbound and outbound commodities at the Port.

Ocean Rates

Ocean freight rates have been developed for the bulk commodities in the short list for the following sizes of vessels operating from the alternative ports:

- Vancouver: 30,000 tonnes for sulphur, potash and phosphate rock and 50,000 tonnes for coal corresponding to the typical size of vessels now moving these commodities;
- Churchill: 30,000 tonnes for all bulk commodities reflecting the effects of limitations on draft and other considerations on the choice of vessel for this port;
- Thunder Bay: 25,000 tonnes for all bulk commodities because of the limitations imposed by the St. Lawrence Seaway.

These vessel sizes are representative for the vessels currently using each of the ports.

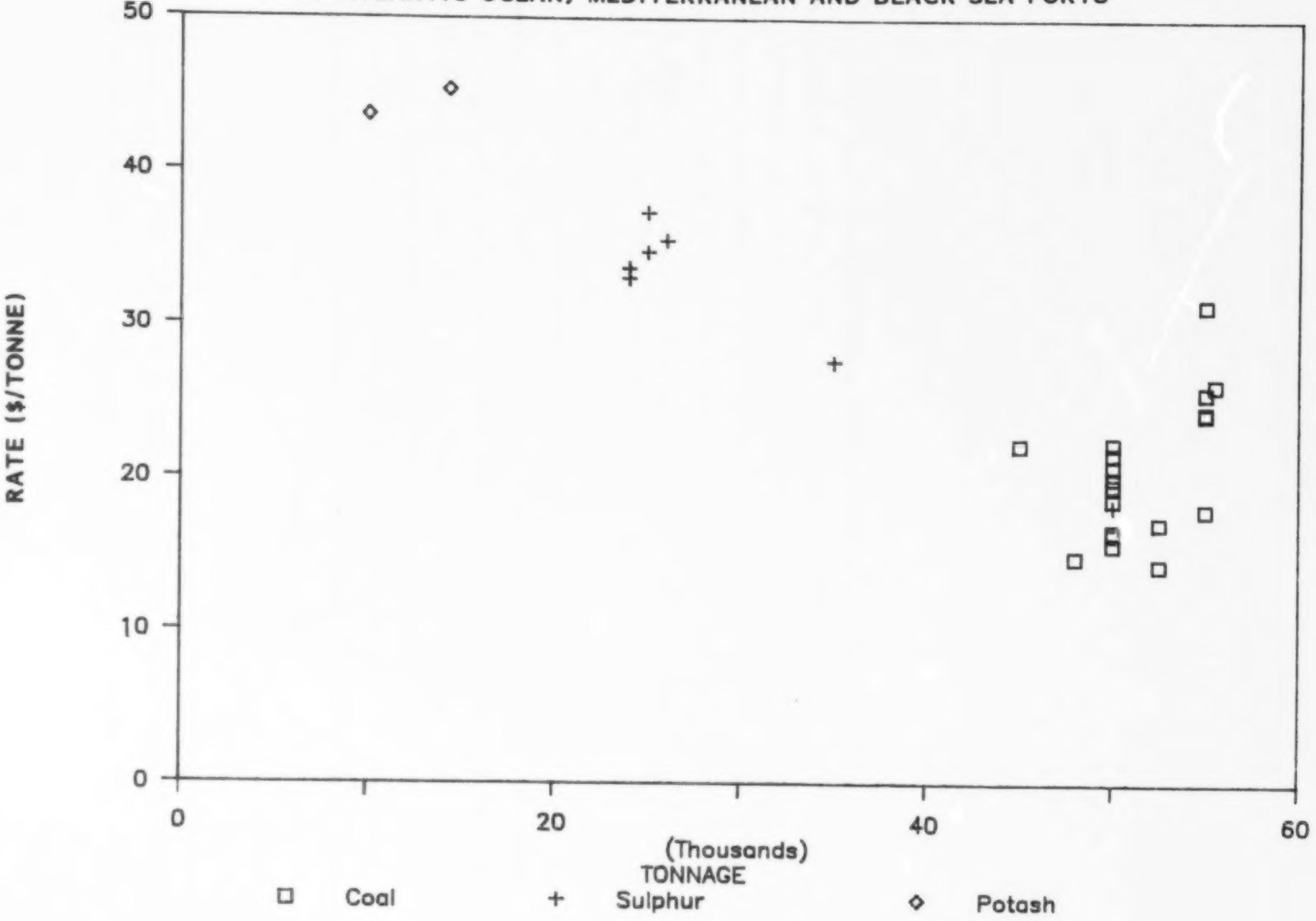
Ocean rates from each of Vancouver, Churchill and Thunder Bay to Europe and North Africa have been established using actual voyage charter rates obtained from the Chartering Annual published by Maritime Research, Inc. Voyage charter rates, which are total rates paid by the shipper to a shipowner for a single specific voyage (e.g. Churchill to Antwerp) as opposed to time charter rates which are rates fixed on a $/day basis excluding charges for fuel, tolls and port charges paid directly by the shipper, are used in the rates comparisons because the large majority of voyages from Churchill are currently voyage charters. Rates have been taken from 1983 through 1985 and individual rates have been indexed to September, 1981 using the miscellaneous and general freight indices published by Maritime Research. The rates indexed to September, 1981 represent values occurring in a medium ocean freight market, in the middle range between the low rates experienced in 1985 and the high rates which were experienced in late 1980. (More information on historical variations in the ocean freight market is provided in Section 3.1.6 of the Study D report.)

Exhibit 3.4 shows shipping rates from Vancouver to European and North African ports for coal, sulphur and potash in Canadian dollars per tonne for various shipload sizes. Although the graph contains rates for

EXHIBIT 3.4

SHIPPING RATES FROM VANCOUVER

TO ATLANTIC OCEAN, MEDITERRANEAN AND BLACK SEA PORTS



SOURCE: 1983 - 1985 CHARTERING ANNUAL, MARITIME RESEARCH INC. U.S.A.

different commodities, it shows a definite trend in the rates which tend to decrease as the ship size or tonnage carried increases. Representative rates for Vancouver were estimated by taking an average of the sulphur rate for ships carrying between 24,000 and 26,000 tonnes to get an average rate for 25,000 tonnes and by taking the coal rates for ships carrying between 45,000 and 55,000 tonnes and estimating an average rate for 50,000 tonnes. Using these two points, the following function was developed to estimate the rate from Vancouver to Europe and North Africa for any shipload size:

rate ($ Canadian/tonne) = 48.37 - .000543 x tonnes

The resulting medium rates from Vancouver for 30,000 and 50,000 tonne ships to Europe/North Africa are as follows:

- 30,000 tonnes - $32.08 per tonne;
- 50,000 tonnes - $21.22 per tonne.

At present the bulk commodities investigated do not move from Churchill and Thunder Bay by ocean vessels. Ocean freight rates for these commodities were estimated based on existing ocean freight rates for grain, adjusted for differences in destinations and in hauling characteristics. Appendix C describes the procedures used. Rates to particular destinations were not estimated as in this comparison it is only the difference that is important. For example, the rates to Morocco and to Egypt can be quite different but the differential in costs from Churchill and from Vancouver should be constant for the different destinations (assuming the same size of vessel) and hence the differentials in rates should also be similar based on the methodology used to estimate these rates (outlined in Appendix C).

The ocean rates described are for movements to Europe and North Africa. For movements from other origins and to other destinations considered in the rate comparisons, ocean rates have been estimated using the following methodology. The current cost of a round trip voyage has been calculated for each commodity movement using the ocean bulk vessel cost model developed for Study D. The ocean rate for a particular movement has then been estimated by multiplying the known ocean rate for shipping to Europe from the port in question by the ratio of the estimated costs of shipping to the given destination and to Europe. A sample calculation for the ocean freight rate from Churchill to South America is provided in Appendix C.

Exhibit 3.5 shows the resulting estimates of marine freight rates.

Rate Comparison

Using the rail rates, terminal rates and ocean freight rates estimated as described in the preceding sub-sections, comparisons have been developed of the costs to the shipper (rates) of shipping bulk commodities to/from Vancouver, Churchill and Thunder Bay for the following individual commodity movements:

- sulphur to each of Northwest Europe, USSR, Northwest Africa and South America (Argentina and Brazil);
- potash to South America (Brazil);
- coal to each of Europe and South America;
- phosphate rock from Florida (Tampa).

These individual movements correspond to the existing movements contained in Exhibit 3.2.

The individual cost comparisons are presented in Exhibits 3.6 through 3.13. For each commodity movement, the comparison considers three different scenarios for rail and ocean rates: low rates, medium rates and

EXHIBIT 3.5

OCEAN FREIGHT RATES FOR NON-GRAIN BULK COMMODITIES
(Medium Ocean Freight Market)
($/tonne)

FROM / TO	NORTHWESTERN EUROPE	USSR	FLORIDA (Tampa)	SOUTH AMERICA (Rio De Janeiro)	AFRICA (Northwest Coast)
Churchill	19.70	23.60	21.40	31.70	22.50
Vancouver					
- 30,000 DWT vessel	32.10	35.60	20.00	29.90	28.50
- 50,000 DWT vessel (coal)	21.20	23.70	13.30	20.00	19.00
Thunder Bay	34.70	40.20	26.90	42.40	31.30

SOURCE: For Northwestern Europe, actual rates published in Maritime Research Inc., Chartering Annual, 1982-1985. Estimates for other destinations based on relative costs obtained from Ocean Bulk Vessel Cost Model (Study D).

EXHIBIT 3.6

COST COMPARISON-SULPHUR TO NORTHWEST EUROPE

SULPHUR	VANCOUVER			CHURCHILL			THUNDER BAY		
ORIGIN	RAM RIVER			RAM RIVER			RAM RIVER		
DISTANCE	1333 KM			2338 KM			2237 KM		
ANNUAL CYCLES	43			26			28		
SHIP SIZE	30,000 TONNES			30,000 TONNES			25,000 TONNES		
COST ($/TONNE)	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE
1. RAIL RATE	18.79	23.90	29.00	29.85	34.96	40.06	28.74	33.85	38.95
2. CAR COSTS	2.06	2.06	2.06	3.40	3.40	3.40	3.16	3.16	3.16
3. TERMINAL COSTS	5.50	5.50	5.50						
4. OCEAN RATES	20.90	32.10	39.50	12.80	19.70	24.20	22.60	34.70	42.70
TOTAL	47.25	63.56	76.06	46.05	58.06	67.66	54.50	71.71	84.81
MAXIMUM CHURCHILL TERMINAL AND EXTRA RAIL-ASSOCIATED COSTS TO BE COMPETITIVE WITH VANCOUVER				1.20	5.50	8.40			

N.B. Terminal Charges at Churchill and Thunder Bay not included

EXHIBIT 3.7

COST COMPARISON-SULPHUR TO U. S. S. R.

SULPHUR	VANCOUVER			CHURCHILL			THUNDER BAY		
ORIGIN	RAM RIVER			RAM RIVER			RAM RIVER		
DISTANCE	1333 KM			2338 KM			2237 KM		
ANNUAL CYCLES	43			26			28		
SHIP SIZE	30,000 TONNES			30,000 TONNES			25,000 TONNES		
COST ($/TONNE)	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE
1. RAIL RATE	18.79	23.90	29.00	29.85	34.96	40.06	28.74	33.85	38.95
2. CAR COSTS	2.06	2.06	2.06	3.40	3.40	3.40	3.16	3.16	3.16
3. TERMINAL COSTS	5.50	5.50	5.50						
4. OCEAN RATES	23.10	35.60	43.80	15.30	23.60	29.00	26.10	40.20	49.40
TOTAL	49.45	67.06	80.36	48.55	61.96	72.46	58.00	77.21	91.51
MAXIMUM CHURCHILL TERMINAL AND EXTRA RAIL-ASSOCIATED COSTS TO BE COMPETITIVE WITH VANCOUVER				0.90	5.10	7.90			

N.B. Terminal Charges at Churchill and Thunder Bay not included

EXHIBIT 3.8

COST COMPARISON-SULPHUR TO NORTHWEST AFRICA

SULPHUR	VANCOUVER			CHURCHILL			THUNDER BAY		
ORIGIN	RAM RIVER			RAM RIVER			RAM RIVER		
DISTANCE	1333 KM			2338 KM			2237 KM		
ANNUAL CYCLES	43			26			28		
SHIP SIZE	30.000 TONNES			30.000 TONNES			25.000 TONNES		
COST ($/TONNE)	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE
1. RAIL RATE	18.79	23.90	29.00	29.85	34.96	40.06	28.74	33.85	38.95
2. CAR COSTS	2.06	2.06	2.06	3.40	3.40	3.40	3.16	3.16	3.16
3. TERMINAL COSTS	5.50	5.50	5.50						
4. OCEAN RATES	18.50	28.50	35.10	14.60	22.50	27.70	20.30	31.30	38.50
TOTAL	44.85	59.96	71.66	47.85	60.86	71.16	52.20	68.31	80.61
MAXIMUM CHURCHILL TERMINAL AND EXTRA RAIL-ASSOCIATED COSTS TO BE COMPETITIVE WITH VANCOUVER				-3.00	-0.90	0.50			

N.B. Terminal Charges at Churchill and Thunder Bay not included

EXHIBIT 3.9

COST COMPARISON-SULPHUR TO SOUTH AMERICA

SULPHUR	VANCOUVER			CHURCHILL			THUNDER BAY		
ORIGIN	RAM RIVER			RAM RIVER			RAM RIVER		
DISTANCE	1333 KM			2338 KM			2237 KM		
ANNUAL CYCLES	43			26			28		
SHIP SIZE	30,000 TONNES			30,000 TONNES			25,000 TONNES		
COST ($/TONNE)	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE
1. RAIL RATE	18.79	23.90	29.00	29.85	34.96	40.06	28.74	33.85	38.95
2. CAR COSTS	2.06	2.06	2.06	3.40	3.40	3.40	3.16	3.16	3.16
3. TERMINAL COSTS	5.50	5.50	5.50						
4. OCEAN RATES	19.40	29.90	36.80	20.60	31.70	39.00	27.60	42.40	52.20
TOTAL	45.75	61.36	73.36	53.85	70.06	82.46	59.50	79.41	94.31
MAXIMUM CHURCHILL TERMINAL AND EXTRA RAIL-ASSOCIATED COSTS TO BE COMPETITIVE WITH VANCOUVER				-8.10	-8.70	-9.10			

N.B. Terminal Charges at Churchill and Thunder Bay not included

EXHIBIT 3.10

COST COMPARISON-POTASH TO SOUTH AMERICA

POTASH	VANCOUVER			CHURCHILL			THUNDER BAY		
ORIGIN	ESTERHAZY			ESTERHAZY			ESTERHAZY		
DISTANCE	2300 KM			1449 KM			1394 KM		
ANNUAL CYCLES	30			41			42		
SHIP SIZE	30,000 TONNES			30,000 TONNES			25,000 TONNES		
COST ($/TONNE)	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE
1. RAIL RATE	29.43	34.54	39.64	20.07	25.18	30.28	19.46	24.57	29.67
2. CAR COSTS	2.95	2.95	2.95	2.16	2.16	2.16	2.11	2.11	2.11
3. TERMINAL COSTS	4.50	4.50	4.50						
4. OCEAN RATES	19.40	29.90	36.80	20.60	31.70	39.00	27.60	42.40	52.20
TOTAL	56.28	71.89	83.89	42.83	59.04	71.44	49.17	69.08	83.98
MAXIMUM CHURCHILL TERMINAL AND EXTRA RAIL-ASSOCIATED COSTS TO BE COMPETITIVE WITH VANCOUVER				13.45	12.85	12.45			

N.B. Terminal Charges at Churchill and Thunder Bay not included

EXHIBIT 3.11

COST COMPARISON-COAL TO EUROPE

COAL	VANCOUVER			CHURCHILL			THUNDER BAY		
ORIGIN	EDMONTON AREA			EDMONTON AREA			EDMONTON AREA		
DISTANCE	1125 KM			2055 KM			2000 KM		
ANNUAL CYCLES	48			31			33		
SHIP SIZE	50,000 TONNES			30,000 TONNES			25,000 TONNES		
COST ($/TONNE)	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE
1. RAIL RATE	16.51	21.62	26.72	26.74	31.85	36.95	26.13	31.24	36.34
2. CAR COSTS	1.84	1.84	1.84	2.85	2.85	2.85	2.68	2.68	2.68
3. TERMINAL COSTS	4.00	4.00	4.00						
4. OCEAN RATES	13.80	21.20	26.10	12.80	19.70	24.20	22.60	34.70	42.70
TOTAL	36.15	48.66	58.66	42.39	54.40	64.00	51.41	68.60	81.72
MAXIMUM CHURCHILL TERMINAL AND EXTRA RAIL-ASSOCIATED COSTS TO BE COMPETITIVE WITH VANCOUVER				-6.24	-5.74	-5.34			

N.B. Terminal Charges at Churchill and Thunder Bay not included

EXHIBIT 3.12

COST COMPARISON-COAL TO SOUTH AMERICA

COAL	VANCOUVER			CHURCHILL			THUNDER BAY		
ORIGIN	EDMONTON AREA			EDMONTON AREA			EDMONTON AREA		
DISTANCE	1125 KM			2055 KM			2000 KM		
ANNUAL CYCLES	48			31			33		
SHIP SIZE	50,000 TONNES			30,000 TONNES			25,000 TONNES		
COST ($/TONNE)	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE
1. RAIL RATE	16.51	21.62	26.72	26.74	31.85	36.95	26.13	31.24	36.34
2. CAR COSTS	1.84	1.84	1.84	2.85	2.85	2.85	2.68	2.68	2.68
3. TERMINAL COSTS	4.00	4.00	4.00						
4. OCEAN RATES	13.00	20.00	24.60	20.60	31.70	39.00	27.60	42.40	52.20
TOTAL	35.35	47.46	57.16	50.19	66.40	78.80	56.41	76.32	91.22
MAXIMUM CHURCHILL TERMINAL AND EXTRA RAIL-ASSOCIATED COSTS TO BE COMPETITIVE WITH VANCOUVER				-14.84	-18.94	-21.64			

N.B. Terminal Charges at Churchill and Thunder Bay not included

EXHIBIT 3.13

COST COMPARISON-PHOSPHATE ROCK FROM FLORIDA

PHOSPHATE ROCK	VANCOUVER			CHURCHILL			THUNDER BAY		
DESTINATION	REDWATER			REDWATER			REDWATER		
DISTANCE	1125 KM			2055 KM			2000 KM		
ANNUAL CYCLES	45			31			33		
SHIP SIZE	30,000 TONNES			30,000 TONNES			25,000 TONNES		
COST ($/TONNE)	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE	LOW RATE	MEDIUM RATE	HIGH RATE
1. RAIL RATE	16.51	21.62	26.72	26.74	31.85	36.95	26.13	31.24	36.34
2. CAR COSTS	1.97	1.97	1.97	2.85	2.85	2.85	2.68	2.68	2.68
3. TERMINAL COSTS	4.50	4.50	4.50						
4. OCEAN RATES	13.00	20.00	24.60	13.90	21.40	26.30	17.50	26.90	33.10
TOTAL	35.98	48.09	57.79	42.49	56.10	66.10	46.31	60.82	72.12
MAXIMUM CHURCHILL TERMINAL AND EXTRA RAIL-ASSOCIATED COSTS TO BE COMPETITIVE WITH VANCOUVER				-7.51	-8.01	-8.31			

N.B. Terminal Charges at Churchill and Thunder Bay not included

high rates. The low, medium and high values for the rail rates have been determined using the rail rate equations described previously. The low and high ocean rates, corresponding to rates that would occur during low and high markets for ocean freight, have been obtained by multiplying the medium rates developed in this chapter and corresponding to the September, 1981 market by correction factors of .65 for the low market and 1.23 for the high market. These correction factors are based on the relative levels of the Maritime Research general freight index in September, 1985 (low market), September, 1981 (medium market) and September, 1980 (high market).

Exhibits 3.6 to 3.13 show that three of the eight individual bulk commodity movements show some possibility of being economic through Churchill compared to the current movement through Vancouver. For these individual movements, namely sulphur to Europe, sulphur to the USSR and potash to South America (Brazil), Churchill would offer the lowest shipping cost of the three routes considered if the Churchill terminal and any additional rail associated costs were less than $5.50 per tonne, $5.10 per tonne, and $12.85 per tonne respectively for each movement during medium ocean freight market conditions. These three potential movements, therefore, warrant further analysis.

For the other five movements examined, the per tonne amounts available to cover terminal handling costs and extra rail associated costs at Churchill are shown to be negative. The primary reasons why each of these movements would be uneconomic through Churchill at present are summarized below:

o Sulphur to Northwest Africa - the rail rate from Alberta production plants (Ram River) to Churchill would be about $11/tonne higher than to Vancouver because of the 75 percent greater rail distance to Churchill, and this difference would not be fully offset by lower ocean rates from Churchill to Northwest Africa ($6/tonne lower than from Vancouver in a medium ocean freight market);

- Sulphur to South America - the rail rate from Alberta to Churchill would be about $11/tonne higher than to Vancouver and ocean rates from Churchill to South America (Brazil) would be slightly higher than rates from Vancouver (by $1.80/tonne in a medium ocean freight market);

- Coal to Europe - the rail rate from the Edmonton area mines to Churchill would be about $10/tonne higher than to Vancouver because of the 83 percent greater rail distance to Churchill, while ocean rates from Churchill to Europe would be only slightly lower (by $1.50/tonne in a medium ocean freight market) than rates from Vancouver because coal from Vancouver would move mainly in large ships carrying 50,000 tonnes or more while, due to existing draft restrictions at Churchill, coal from Churchill would commonly move in 25,000-30,000 tonne shiploads;

- Coal to South America - the rail rate to Churchill would be higher than to Vancouver as discussed above and ocean rates from Churchill to South America (Brazil) would be considerably higher than from Vancouver (by $11.70/tonne in a medium ocean freight market) due mainly to larger coal vessels being used from Vancouver;

- Phosphate Rock from Florida - the rail rate from Churchill to phosphate plants in Alberta (Redwater) would be about $10/tonne higher than from Vancouver because of the 83 percent greater rail distance from Churchill, and ocean rates from Florida to Churchill would be slightly greater than to Vancouver (by $1.40/tonne in a medium ocean freight market).

Shipping through Thunder Bay is more expensive than shipping through Churchill for each of the eight additional commodity movements included in the comparison. There is also no margin available for terminal costs in Thunder Bay, compared with Vancouver, except in the case of potash movements where there is a small amount available. The Thunder Bay route has therefore been left out of additional comparisons.

Based on the results of these cost comparisons for individual commodity movements, it appears that only sulphur and potash have transportation costs low enough to make movement through Churchill economic given current origin and destination patterns, before considering terminal costs at Churchill. However, since phosphate rock movements from Florida could serve as a backhaul to outbound potash and/or sulphur to reduce the total cost of a combined movement, the phosphate rock movement is retained for consideration in the next section, which provides a cost comparison for various combined movements of sulphur, potash and phosphate rock.

It should also be noted that the rates shown are for transportation and handling only. No allowance has been made to this point for any extra costs introduced by the short navigation season at Churchill.

3.2.2 Cost Comparisons for Combination Movements

As noted previously, in this sub-section we examine the costs relative to the alternative routing through Vancouver of shipping various combinations of sulphur, potash and phosphate rock volumes through the Port of Churchill. The reason that joint commodity scenarios have been examined is that using the Port of Churchill to handle more than one non-grain commodity movement would increase the total volume of product handled through the Port and might therefore reduce the unit terminal handling costs at the Port through economies of scale (terminal handling methods and costs are examined in Chapter 4). The joint commodity schemes considered, along with the individual commodity movements described in subsection 3.2.1 which warrant further cost analysis, are listed in Exhibit 3.14 along with their associated inbound and outbound throughput volumes.

Commodity schemes 2A, 3B, 4A and 6B include the shipment through Churchill of the entire year's volume of potash to South America (290,000 tonnes) and phosphate rock from Florida (300,000 tonnes), while the other schemes assume that only one quarter of the annual commodity volumes (shown in Exhibit 3.1) would be shipped through Churchill during its current three month shipping season so that no extra inventory period

EXHIBIT 3.14

COST EVALUATION OF POTENTIAL JOINT BULK COMMODITY MOVEMENTS THROUGH CHURCHILL

COMMODITY SCHEME	VOLUME (TONNES PER YEAR)		MAXIMUM CHURCHILL TERMINAL AND EXTRA RAIL-ASSOCIATED COSTS TO BREAK EVEN WITH VANCOUVER ROUTE ($/tonne)		
	THROUGHPUT INBOUND	THROUGHPUT OUTBOUND	LOW FREIGHT RATES	MEDIUM FREIGHT RATES	HIGH FREIGHT RATES
1. Sulphur to Europe and USSR		210,000	1.11	5.43	8.26
2A. Potash to South America with year-round rail shipment to Churchill		290,000	9.38	8.40	7.77
2B. Potash to South America		72,500	13.48	12.85	12.44
3A. Sulphur to Europe and USSR and Potash to South America		210,000 (sulphur) 72,500 (potash) 282,500	4.27	7.32	9.33
3B. Sulphur to Europe and USSR and Potash to South America with year-round rail shipment of Potash to Churchill		210,000 (sulphur) 290,000 (potash) 500,000	5.90	7.15	7.97
4A. Potash to South America with Phosphate Rock backhaul from Florida and year-round rail shipment to/from Churchill	300,000	290,000	-1.49 to -0.43*	-2.52 to -1.46*	-2.90 to -1.84*
4B. Potash to South America with Phosphate Rock backhaul from Florida	75,000	72,500	1.60 to 2.66*	.95 to 2.01*	.52 to 1.58*
5. Sulphur to Europe and USSR with Phosphate Rock backhaul from Florida	75,000	210,000	-1.03 to 1.46*	.12 to 1.21*	1.60 to 2.69*
6A. Sulphur to Europe and USSR, Potash to South America with Phosphate Rock backhaul from Florida	75,000	210,000 (sulphur) 72,500 (potash) 282,500	1.32 to 1.75*	3.59 to 4.02*	5.07 to 5.51*
6B. Sulphur to Europe and USSR, Potash to South America with Phosphate Rock backhaul from Florida and year-round rail shipment of Potash and Phosphate Rock to/from Churchill	300,000	210,000 (sulphur) 290,000 (potash) 500,000	-1.21 to -.03*	-0.43 to 0.35*	.03 to .81*

* Range of values, actual value depending upon the total railway charge for the part of the rail movement having a backhaul. The left-hand value in the range assumes that the railway charges 1.8 times the normal one-way rate for the two-way journey with backhaul, while the right-hand value assumes that the railway charges 1.2 times the normal one-way loaded rate for the two-way journey with backhaul.

would be needed. Shipping a full year's volume through Churchill would require that a commodity be held in inventory for an extended period of time at both ends of the movement. Production and consumption of all these commodities is fairly uniform throughout the year; therefore, the commodity would have to be stockpiled for an average of four and one half months (the nine month period during which Churchill is closed divided by two) at both the origin and destination ends of the movement if a year's volume were shipped through Churchill. The commodity could be stockpiled at the Port of Churchill, at the mine/plant producing or consuming the commodity, or at both locations. Whichever way the physical stockpiles are distributed, extra inventory carrying cost would be incurred by using the Port of Churchill instead of the Port of Vancouver which is open year-round. This extra inventory interest carrying cost, which excludes the capital and maintenance costs of extra storage space and facilities, has been calculated using the following formula:

extra inventory interest carrying cost averaged over all the year's movements (\$ per tonne) = $i \times 4.5/12 \times (V + (V + OR)) \times 9/12$

where i = annual interest rate, currently assumed to be 11 percent
V = value of commodity (FOB selling price) in dollars per tonne
OR = ocean rate for the ocean movement to the destination.

In this formula, the ocean rate has been added to the value (FOB selling price) of the commodity in calculating the inventory interest cost at the destination end because the value of the commodity at that end would include the value added by the transportation component, for a total of V + OR. The multiplier 9/12 is a pro-rating factor reflecting the shipping season length, i.e. Churchill is closed 9 months of the year and product produced or consumed during these 9 months and shipped via Churchill incurs extra inventory costs (while that produced or consumed during the three months Churchill is open does not incur such extra costs).

Commodity values of $160 per tonne for sulphur, $56 per tonne for potash and $32 per tonne for phosphate rock, obtained from industry sources and representing late 1985 export prices, have been used in calculating the extra inventory costs. The additional costs introduced by this factor are:

- sulphur - $10.53 per tonne;
- potash - $4.45 per tonne;
- phosphate rock - $2.75 per tonne.

If the Churchill navigation season were extended to one-third of a year (approximately 4 months or 17 weeks), then the additional inventory interest carrying charge would be represented by:

$$i \times 4/12 \times (V + (V + OR)) \times 8/12$$

The results would then be estimated as follows:

- sulphur - $8.32 per tonne;
- potash - $3.52 per tonne;
- phosphate rock - $2.17 per tonne.

These possible changes in the inventory carrying charges are considered in Section 5.2 in discussing the sensitivity of the results to changes in assumptions concerning length of season.

Because of the relatively high value of sulphur, movement of the full year's volume of sulphur through Churchill to Europe and to the USSR would be uneconomic because it would add an average charge of $10.53 per tonne to the charges involved in shipping only one quarter of a year's supply. Potash still has some margin to cover possible terminal costs and additional rail costs associated with Churchill.

The final three columns in Exhibit 3.14 summarize the results of the calculations performed to compare the costs of shipping through Churchill versus shipping through Vancouver for each of the joint commodity schemes considered. The values given represent the maximum terminal handling and extra rail associated costs for movement through Churchill that would still make the Churchill route economical relative to the Vancouver route, for each of the three different ocean freight market and rail rate scenarios discussed in sub-section 3.2.1. The values given for each commodity scheme represent weighted averages over the specific commodity movements contained in the scheme and allow consistent comparisons to be made between the various schemes. Because the maximum Churchill terminal and extra rail associated costs to break even are seen to be negative for commodity schemes 4A and 6B and very small for schemes 4B and 5 (considerably less than the known terminal charge for potash and phosphate rock at Vancouver of $4.50 per tonne), it has been concluded that these four schemes for movement through Churchill are uneconomical and Schemes 4A, 4B and 5 have been eliminated from further consideration. Scheme 6B has been retained because it includes the largest total volume (800,000 tonnes) of all the schemes considered and therefore its associated terminal costs, calculated in Chapter 4, are of interest in that they represent minimum terminal costs attainable at Churchill if movement of such large volumes of additional bulk commodities were feasible.

3.2.3 Results of Second Screening

Based on the cost results shown in Exhibit 3.14, the following schemes for potential movement through Churchill are retained for complete cost comparisons with the alternative Vancouver route in Chapter 5 taking into account terminal costs in Churchill and any additional rail costs associated with Churchill movements:

- sulphur to Europe and USSR during the Churchill navigation season;

- potash to South America during the Churchill navigation season;
- potash to South America with year-round rail shipment to Churchill;
- sulphur to Europe and USSR and potash to South America during the Churchill navigation season;
- sulphur to Europe and USSR and potash to South America with year-round rail shipment of potash to Churchill;
- sulphur to Europe and USSR, potash to South America with phosphate rock backhauled from Florida, moved only during the Churchill navigation season;
- sulphur to Europe and USSR, potash to South America with phosphate rock backhauled from Florida and year-round rail shipment of potash and phosphate rock to/from Churchill.

4. PORT OF CHURCHILL TERMINAL FACILITIES AND COSTS

In this chapter, the existing facilities for commodity handling at the Port of Churchill are briefly described. The improvements required to enable the Port to handle additional bulk commodities are then described and terminal charge estimates are provided for various handling schemes. These estimated terminal charges are then used in Chapter 5 to make final comparisons of the shipper costs for the potential joint commodity movements through Churchill given at the end of Chapter 3.

4.1 DESCRIPTION OF EXISTING PORT FACILITIES

The existing wharf at the Port of Churchill is 843 metres long. The grain loading gallery extends along the wharf over a length of 448 metres, with distances from the gallery ends to the north and south ends of the wharf of 192 and 203 metres respectively.

The wharf is adequate to accommodate four 30,000 DWT vessels. The length of coverage along the wharf provided by the grain shipping gallery is more than adequate to load two 30,000 DWT vessels simultaneously.

The transit shed and petroleum product manifold are located within the wharf length, paralleled by the grain shipping gallery. With existing minimum dredged depths of 9.5 m at the north berth, 9.0 m to 9.8 m alongside the shipping gallery and 9.0 m at the south berth, loaded draft restrictions apply to vessels of 30,000 DWT and larger at lower tide levels. For the ensuing analysis the existing wharf has been considered as four berths, comprised of a north berth, a south berth, and two grain loading berths.

The two grain berths are paralleled by the grain loading gallery and by the transit shed over part of their lengths and are considered unsuitable for handling non-grain commodities due to restrictions on the area available for additional fixed materials handling equipment and on-ground storage. The south berth is presently used primarily for tying up port service tugs and supply vessels for oil exploration and other development north of Churchill. Assuming that a shallow draft berth were provided elsewhere to accommodate the port tugs and supply vessels, the south berth could become available for handling of non-grain commodities. However, with the existing limitations on placement of on-ground storage and of fixed materials handling equipment, handling inbound or outbound bulk products at this berth also appears impractical.

At present primary use of the north berth is for tying up vessels waiting to move to one of the grain loading berths. The Northern Transportation Company Ltd. (NTCL) resupply cargo operations presently take place over the wharf area associated with this berth, occupying the wharf north end and the back side of the wharf in the winter berth area. Large areas of the wharf apron are occupied with materials awaiting loading onto the NTCL marine equipment.

If the facility for NTCL were to be provided elsewhere, or if it were agreed that the eastern half of the wharf apron area paralleling the north berth would be adequate for their purposes, the north berth could be utilized to accommodate vessels involved in the transport of inbound or outbound non-grain bulk materials.

Based on discussions with Port of Churchill officials, the existing rail trackage at the Port is assumed to be fully required to handle grain through the Port, especially at larger volumes beyond about 600,000 tonnes per year. Consequently, additional operating and storage trackage would be required for the regular handling of non-grain commodities through the Port.

Further details on the existing facilities at the Port of Churchill are provided in Appendix D.

4.2 IMPROVEMENTS REQUIRED FOR ADDITIONAL COMMODITIES

Since the existing facilities at the Port of Churchill are geared to the movement of grains and Arctic resupply cargos, the addition of other commodities moving through the Port would require substantial improvements to material handling facilities. The material handling requirements include both the capital and operating cost implications relating to the handling through the Port of non-grain commodities.

Eight basic material handling schemes for the inbound and outbound non-grain commodities identified as having potential for movement through Churchill have been investigated. Investigations were directed toward obtaining:

- an assessment of throughput capacity achievable;
- order-of-magnitude capital and operating costs;
- identification of limitations and restrictions as well as relative advantages and disadvantages.

In developing these alternatives, particularly in Schemes 1, 2 and 5, efforts were made to propose operating facilities suitable to the relatively low volumes of movement expected.

A detailed description along with a summary of related costs, operating features and limitations of each of the individual schemes is given in Appendix E of this report.

4.2.1 Assumptions

The investigation of material handling requirements covered a range of possible volumes of inbound and outbound bulk commodities, from 72,500 tonnes to 1.4 million tonnes, as determined by existing volumes for the movements considered in Chapter 3 to be possible movements through Churchill.

All of the inbound solid bulk commodities investigated were assumed to be relatively free flowing at normal, commercially accepted moisture content levels, and could be readily unloaded from self-unloading vessels equipped with tunnel reclaim/boom conveyor discharge. It was assumed that none of the inbound or outbound bulk commodities with the exception of sulphur would be stockpiled unprotected, since potash and phosphate rock deteriorate when exposed to precipitation. Potash dissolves and phosphate rock becomes caked. It was also assumed in most cases that it would not be possible to coordinate train and ship arrivals at Churchill closely enough that product could be feasibly transferred directly from rail car to ship without the need for intermediate storage, and so the handling schemes include appropriate allowances for operating storage facilities (surge bins, storage buildings or stockpiles but not intended for seasonal storage).

4.3 COST IMPLICATIONS

Using the estimated costs for required dredging and wharf improvements and for new handling facilities, a total cost per tonne moved has been calculated for each of the basic handling schemes. These are shown on Exhibit 4.1.

The potential joint commodity proposals for movement through Churchill in the short list given at the end of Chapter 3 would make use of variations on handling Schemes 5 and 8. Using the detailed capital and operating costs included in Schemes 5 and 8 (given in Appendix E), we have calculated terminal costs separately for each of the potential joint commodity movements. The results are presented in Exhibit 4.2.

In the cost calculations all of the capital costs for materials handling facilities are based on an assumed useful life of 15 years and railway trackage, storage buildings and facilities and any new wharfs or harbour facilities are assumed to have a life of 30 years. An interest rate of 11 percent for amortization has been used, representing the rate

EXHIBIT 4.1

TERMINAL CHARGES

SCHEME	DESCRIPTION	OUTPUT (TONNES)			CAPITAL COSTS ($)						OPERATING COSTS ($)	TOTAL ANNUAL COSTS ($)	TOTAL COST/ TONNE ($)
		Thruput Inbound	Thruput Outbound	Total thruput	Wharf	Loading Facilities	Track	Storage Facilities	Total	Annual			
SCHEME 1	-no storage -loading on wharf	200,000 300,000		200,000 300,000		1,600,000	3,500,000	0	5,100,000	625,090	904,000 1,081,000	1,529,090 1,706,090	7.65 5.69
SCHEME 2	-no storage -load conveyed to single car onshore	200,000 300,000 400,000		200,000 300,000 400,000		3,240,000	5,420,000	0	8,660,000	1,074,005	824,000 968,000 1,113,000	1,898,005 2,042,005 2,187,005	9.49 6.81 5.47
SCHEME 3	-no storage -self-unloading vessel -double car loading on shore -1000MT/h transfer system	200,000 400,000 600,000		200,000 400,000 600,000 0		4,780,000	5,580,000	0	10,360,000	1,306,569	127,000 254,000 381,000	1,433,569 1,560,569 1,687,569	7.17 3.90 2.81
SCHEME 4	-30,000 MT storage on shore -self-unloading vessel -2000MT/h transfer system	500,000 700,000 900,000		500,000 700,000 900,000		7,350,000	3,900,000	3,000,000	14,250,000	1,815,799	740,000 909,000 1,078,000	2,555,799 2,724,799 2,893,799	5.11 3.89 3.22
SCHEME 5	-stockpiled near rail yard -transfer by truck to dock -loaded using clam cranes		200,000 300,000 400,000	200,000 300,000 400,000		1,200,000	2,350,000	400,000	3,950,000	483,196	1,779,000 2,194,000 2,621,000	2,262,196 2,677,196 3,104,196	11.31 8.92 7.76
SCHEME 6	-separate north dock -30,000MT storage	600,000	200,000	800,000	29,390,000	8,630,000	5,580,000	3,000,000	46,600,000	5,567,617	548,000 517,000		7.87 9.54
SCHEME 7A	-pulpwood -direct transfer from open flat cars		100,000	100,000			1,770,000		1,770,000	203,594	724,000	927,594	9.28
SCHEME 7B	-paper rolls -unloaded from box cars to dock apron		100,000	100,000			1,770,000		1,770,000	203,594	995,000	1,198,594	11.99
SCHEME 8	-outbound sulphur and potash: -railcar to unloading pit, conveyor to storage (potash) stockpile (sulphur) -conveyor to north dock, loaded by shiploader -inbound phosphate rock: -self-unloaders,conveyor to storage to car load-out facility	300,000	1,130,000	1,430,000		26,800,000	2,800,000	10,000,000	39,600,000	5,199,263	755,000	5,954,263	4.16

Note : Amortization Rate - 11%
Life Expectancy : Wharf - 30 years
Loading Facilities - 15 years
Trackage - 30 years
Storage Facilities - 30 years

EXHIBIT 4.2

TERMINAL CHARGES FOR JOINT BULK COMMODITY MOVEMENTS THROUGH CHURCHILL

COMMODITY SCHEME	OUTPUT (TONNES)			CAPITAL COSTS ($)						OPERATING COSTS ($)	TOTAL ANNUAL COSTS ($)	TOTAL COST/ TONNE ($)
	THROUGHPUT INBOUND	THROUGHPUT OUTBOUND	TOTAL THROUGHPUT	WHARF	LOADING FACILITIES	TRACK	STORAGE BUILDINGS/ FACILITIES	TOTAL	ANNUAL CAPITAL			
1. Sulphur to Europe and U.S.S.R.		210,000	210,000		1,200,000	2,350,000	400,000	3,950,000	483,170	1,820,500	2,303,670	10.97
2. Potash to South America with Year-Round Rail Shipment to Churchill		290,000	290,000		14,800,000	2,800,000	5,000,000	22,600,000	2,955,680	194,900	3,150,580	10.86
2b Potash to South America		72,500	72,500		14,800,000	2,800,000	3,500,000	21,100,000	2,783,000	50,000	2,833,000	39.08
3a Sulphur to Europe and U.S.S.R. and Potash to South America		210,000 (sulphur) 72,500 (potash) 282,500	282,500		14,800,000	2,800,000	5,500,000	23,100,000	3,013,180	190,000	3,203,180	11.34
3b Sulphur to Europe and U.S.S.R. and Potash to South America with Year-Round rail shipment of Potash to Churchill		210,000 (sulphur) 290,000 (potash) 500,000	500,000		14,800,000	2,800,000	7,000,000	24,600,000	3,185,680	337,000	3,522,680	7.05
6a Sulphur to Europe and U.S.S.R., Potash to South America with Phosphate Rock Backhaul from Florida	75,000	210,000 (sulphur) 72,500 (potash) 282,500	357,500		15,200,000	2,800,000	5,900,000	23,900,000	3,114,800	850,000	3,964,800	11.09
6b Sulphur to Europe and U.S.S.R., Potash to South America with Phosphate Rock Backhaul from Florida and Year-Round rail shipment of Potash and Phosphate Rock to/from Churchill	300,000	210,000 (sulphur) 290,000 (potash) 500,000	800,000		26,800,000	2,800,000	10,000,000	39,600,000	5,199,880	437,000	5,636,800	7.05

charged to public works projects by Treasury Board in late 1985. This rate implies a conservative value for the required return on capital for new investments made at the Port of Churchill. If the investments were to be made by private companies, a greater return on capital (such as 19 percent which is allowed by the WGTA for capital investments in grain handling and transportation infrastructure) would probably be required and the terminal charges at Churchill would as a result be somewhat higher than those estimated here.

We have checked the sensitivity of the terminal cost estimates to longer assumed service lives for the various facilities (which might be obtainable at Churchill because of its short shipping season and hence lower use of the facilities each year compared to other ports) by recalculating the costs in Exhibit 4.2 using service lives of 20 years for the loading/unloading facilities and 50 years for the railway trackage, storage buildings/facilities and wharf facilities. The results, given in Appendix F, show that the per tonne cost estimates would change relatively little with these longer service life assumptions and we have used the values in Exhibit 4.2 in the final cost comparisons.

As shown in Exhibit 4.2, the average total cost per tonne for handling the candidate inbound or outbound commodities ranges from $7.05 for commodity Scheme 6B (a total of 800,000 tonnes of outbound sulphur and potash and inbound phosphate rock) to $39.08 for Scheme 2B (72,500 tonnes of outbound potash). As expected, rates are substantially lower for higher throughputs.

The terminal rates developed here are used in Chapter 5 in order to compare total shipper cost of moving the potential combinations of commodities through Churchill compared with the costs of moving through Vancouver.

5. OVERALL COST COMPARISON FOR POTENTIAL BULK COMMODITY MOVEMENTS THROUGH PORT OF CHURCHILL

This chapter presents comparisons of the total costs to shippers of moving each of the seven combinations of bulk commodities listed at the end of Chapter 3 through the Port of Churchill versus through Vancouver. These final comparisons take into account the potential terminal charges at Churchill estimated in Chapter 4, as well as additional costs associated with the requirement to upgrade the Churchill rail line to accommodate conventional hopper and open gondola cars as discussed below. The chapter concludes by briefly discussing the results of the total cost comparisons.

5.1 EXTRA RAIL COSTS OF USING THE CHURCHILL LINE FOR ADDITIONAL BULK COMMODITIES

At present, conventional hopper and open gondola cars cannot be used on the Churchill rail line because of the problem of differential settlement of the line in permafrost areas which can cause derailment of these cars, particularly when they are empty. Since it would be neither practical nor economic to use boxcars for potash, sulphur or phosphate rock, the establishment of regular shipments by rail of these bulk commodities to/from Churchill would necessitate taking one of the following two[1] possible actions:

- purchase articulated hopper cars - CN has developed and is currently testing a prototype articulated hopper car that could be used on the Churchill line. While this prototype car has been developed specifically to carry grain, it is reasonable to assume that the design could be modified to accommodate potash, phosphate rock and sulphur movements (the latter requiring that the car be open). The bulk commodity shippers would need to purchase enough of these articulated cars to accommodate required movements of product to/from Churchill;

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[1] A third alternative action to allow sulphur shipments would be to use the old 50-tonne capacity wooden bottom open gondola cars used for the Amoco shipments in the 1970's. However, because of the age and low capacity of these cars they would be uneconomic compared to modern large gondola cars and, furthermore, we understand that most of these cars have now been retired by CN. This alternative has therefore not been considered further.

- refurbish the Churchill line - the Churchill line would be permanently stabilized, possibly by installing a cryo-anchor system to help equalize soil temperatures, such that conventional hopper cars could be used on the line.

Below we compare the extra costs associated with each of these two rail related strategies for shipping additional bulk commodities to/from Churchill relative to the current costs associated with the conventional hopper cars moving to/from Vancouver.

Exhibit 5.1 compares the per tonne capital and operating costs for the articulated hopper car and the conventional hopper car. Capital costs have been estimated based on an assumed economic life of the cars of 30 years and an annual interest rate of 11 percent. The operating cost per loaded car-mile for the conventional hopper car is that given for government grain hopper cars in a recent CTC report[2]. The corresponding cost used for the articulated hopper car is an upper bound estimate determined in Appendix E of Study D.

In calculating the costs associated with using articulated hopper cars to carry additional bulk commodities to/from Churchill, we have considered two cases:

- articulated hopper cars used for Churchill only - articulated hopper cars purchased would be used only for movements to/from Churchill and would be removed from service during the part of the year when the Port is closed. This car strategy would be necessary in the short term because shippers of potash, sulphur and phosphate rock currently have sufficient numbers of conventional hopper cars to handle existing movements

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[2] "RTC Staff Report Concerning the Payment of the CN Adjustment to the Canadian National Railway Company in Respect of Crop Year of 1985/86 Under the Western Grain Transportation Act", Canadian Transport Commission Report No. REA-CD-86-01, February, 1985.

EXHIBIT 5.1

COMPARISON OF CAPITAL AND OPERATING COSTS FOR CONVENTIONAL AND ARTICULATED HOPPER CARS CARRYING ADDITIONAL BULK COMMODITIES

(A) CAPITAL COSTS

	CAPITAL COST ($)	LOAD* (tonnes)	CAPITAL COST/ TONNE ($)	LIFE (years)	COST/YEAR/ TONNE** ($)	TURNS/ YEAR***	COST/ TONNE ($)
1. Articulated Hopper	85,000[1]	98	867.35	30	99.76	36	2.77
2. Conventional Hopper	70,000	91	769.23	30	88.48	36	2.46
3. Articulated Hopper used for Churchill only	85,000	98	867.35	30[2]	99.76	9	11.08
4. Articulated Hopper used for Churchill during Churchill season and to Vancouver during rest of year	85,000	98	867.35	30	99.76	9	3.71[3]

* Assumes cars are loaded to maximum capacity

** Based on an interest rate of 11$

*** Based on the car cycle formula in Chapter 3 using an average one-way haul of 1,800 km

1. Estimated cost; actual cost will depend on number ordered and where the cars are constructed and could be as much as $100,000.

2. The same economic life is used for the articulated cars when they sit idle outside the Churchill shipping season as when they are used for Vancouver during the off-season because it is assumed that if the cars were not physically worn out they would be obsolete in 30 years.

3. Excess capital costs of $99.76/year/tonne above $88.48/year/tonne ($11.28/year/tonne) assigned to the 9 Churchill trips only, producing an additional cost of $1.25/tonne, which is added to base cost of $2.46/tonne on trips to Churchill

(B) OPERATING COSTS

	OPERATING COST/ LOADED CAR-MILE ($)	LOAD (tonnes)	DISTANCE (miles)	COST/TONNE ($)
1. Articulated Hopper	1.10[5]	98	1,120	12.57
2. Conventional Hopper	.782	91	1,120	9.62
3. Articulated Hopper used for Churchill only	1.10[5]	98	1,120	12.57
4. Articulated Hopper used for Churchill during Churchill season and to Vancouver during rest of year	1.10[5]	98	1,120	21.42[4]

4. The extra operating cost of $2.95/tonne (= $12.57 - $9.62) required for the articulate hopper over the conventional hopper is multiplied by four to reflect four times as mu use of the cars if they are used year-round instead of during the 3-month Churchill season only, and the product ($11.80/tonne) is assigned fully to trips to Churchill and added to the base cost of $9.62/tonne for the conventional hopper.

5. Estimated

without needing the extra capacity that would be provided by the purchase of articulated hopper cars, and would use the conventional equipment for all non-Churchill movements because of its lower unit operating cost (see Exhibit 5.1 (B));

- articulated hopper car used year round - the articulated hopper cars would be used in the Churchill service when required but would otherwise be used to move bulk commodities to/from Vancouver. This option might apply in the long term as conventional hopper cars are removed over time from shippers fleets.

The specific capital and operating costs associated with each of these two cases are shown under points 3 and 4 in Exhibit 5.1.

Exhibit 5.2 summarizes the extra costs associated with each of the car/rail line policies for enabling additional bulk commodity movements to Churchill relative to the base costs for conventional hopper cars to Vancouver. Two different estimates of the line related capital costs for refurbishing the Churchill line to accommodate conventional hoppers have been used. In 1982, the potential costs of the line refurbishment were estimated[3]. These estimated costs have been said, by CN, to be low because not all of the problem locations on the line were identified. To take into account this uncertainty, we have arbitrarily doubled the original $17,500,000 estimate (converted to 1985 dollars) and considered the resulting $35 million capital cost as an upper value for the purposes of our analysis. It should be noted that estimates as high as $50,000,000 (in 1982 dollars) for stabilizing the roadbed on the Churchill line have been mentioned, reflecting the considerable uncertainty as to what the actual cost would be.

It is seen from the exhibit that refurbishment of the Churchill line appears to be the most economical option for additional bulk commodity movements to Churchill if more than 350,000 tonnes of all

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[3] "Embankment Stabilization Research Program: Branch Line Rehabilitation for the Hudson Bay Railway, Herchmer Subdivision", EBA Engineering Consultants, September 1982.

EXHIBIT 5.2

DIFFERENTIAL COSTS OF VARIOUS CAR POLICIES FOR ADDITIONAL BULK COMMODITIES

(A) CAR RELATED COSTS

	CONVENTIONAL HOPPER CAR	ARTICULATED HOPPER CAR	ARTICULATED HOPPER CAR USED FOR CHURCHILL ONLY	ARTICULATED HOPPER CAR USED THROUGHOUT YEAR, EXCESS COST ALLOCATED TO CHURCHILL MOVEMENT
Car Capital Costs ($/Tonne)	2.46	2.77	11.08	3.71
Per Car-Mile Costs ($/tonne)	9.62	12.57	12.57	21.42
Subtotal	12.08	15.34	23.65	25.13
Excess of Cost over Conventional Hopper Car ($/tonne)	-	3.26	11.57	13.05

(B) LINE RELATED CAPITAL COSTS FOR REFURBISHMENT

	$17,500,000 COST ESTIMATE				
Churchill Annual Throughput (tonnes)	250,000	500,000	750,000	1,000,000	1,250,000
Cost per Tonne ($/tonne)	8.00	4.00	2.67	2.00	1.60
	$35,000,000 COST ESTIMATE				
Churchill Annual Throughput (tonnes)	250,000	500,000	750,000	1,000,000	1,250,000
Cost per Tonne ($/tonne)	16.00	8.00	5.33	4.00	3.20

commodities were moved over the line each year. A similar analysis of the trade-off between refurbishment of the line and purchase of specialized cars reported on in Study D resulted in a higher estimate of the volume of grain required to make refurbishment of the line preferable, because of the potential use of the Churchill articulated hopper cars on load restricted branch lines during the remainder of the year. However, since the existing grain movements alone over the Churchill line have averaged about 500,000 tonnes per year over the past five years, the line refurbishment option appears to be the most economical for substantial volumes of additional bulk commodities. In Study D it was recommended that, if Churchill is to be retained as a grain port, it should be used to carry substantial volumes of grain, 600,000 tonnes per year or more. We assume in our final cost comparisons given in the next section that the extra rail related costs for moving the various combinations of potash, sulphur and phosphate rock to/from Churchill can be estimated on the basis of sharing the additional line costs between 750,000 tonnes of grain and the various volumes of additional bulk commodities.

5.2 FINAL COST COMPARISONS

Exhibit 5.3 presents the overall comparison of the cost to shippers of moving each of the various combinations of potash, sulphur and phosphate rock identified in Chapter 3 as potential movements to/from Churchill relative to the costs of moving them through Vancouver, including terminal costs at Churchill and costs for refurbishing the Churchill line to accommodate conventional hopper cars. It is seen that none of the commodity schemes considered could be handled through Churchill on an economic basis at present. This is true under all scenarios for freight rates. The commodity scheme with the smallest potential loss is Scheme 3B (sulphur to Europe and USSR and potash to South America with a full year's shipment of potash), estimated to be between $1.48 per tonne and $3.55 per tonne more expensive than handling these movements through Vancouver. The most uneconomic movement considered, shipping 72,500 tonnes per year of potash to South America,

EXHIBIT 5.3

FINAL COST EVALUATION OF POTENTIAL JOINT BULK COMMODITY MOVEMENTS THROUGH CHURCHILL

COMMODITY SCHEME	VOLUME (TONNES PER YEAR)		MAXIMUM CHURCHILL TERMINAL AND EXTRA RAIL-ASSOCIATED COSTS TO BREAK EVEN WITH VANCOUVER ROUTE ($/tonne)			TERMINAL COSTS AT CHURCHILL ($/tonne)	CHURCHILL LINE REFURBISHMENT COST** ($/tonne)	TOTAL SAVINGS AVAILABLE BY USING CHURCHILL ROUTE INSTEAD OF VANCOUVER ROUTE		
	THROUGHPUT INBOUND	THROUGHPUT OUTBOUND	LOW FREIGHT RATES	MEDIUM FREIGHT RATES	HIGH FREIGHT RATES			LOW FREIGHT RATES	MEDIUM FREIGHT RATES	HIGH FREIGHT RATES
1. Sulphur to Europe and USSR		210,000	1.11	5.43	8.26	10.97	3.10	-12.96	-8.64	-5.81
2A. Potash to South America with year-round rail shipment to Churchill		290,000	9.38	8.40	7.77	10.86	2.90	-4.38	-5.36	-5.99
2B. Potash to South America		72,500	13.48	12.85	12.44	39.08	3.60	-29.20	-29.83	-30.24
3A. Sulphur to Europe and USSR and Potash to South America		210,000 (sulphur) 72,500 (potash) 282,500	4.27	7.32	9.33	11.34	2.90	-9.97	-6.92	-4.91
3B. Sulphur to Europe and USSR and Potash to South America with year-round rail shipment of Potash to Churchill		210,000 (sulphur) 290,000 (potash) 500,000	5.90	7.15	7.97	7.05	2.40	-3.55	-2.30	-1.48
6a. Sulphur to Europe and USSR, Potash to South America with Phosphate Rock backhaul from Florida	75,000	210,000 (sulphur) 72,500 (potash) 282,500	1.32 to 1.75*	3.59 to 4.02*	5.07 to 5.51*	11.09	2.70	-12.47 to -12.04*	-10.20 to -5.77*	-8.72 to -8.28*
6b. Sulphur to Europe and USSR, Potash to South America with Phosphate Rock backhaul from Florida and year-round rail shipment of Potash and Phosphate Rock to/from Churchill	300,000	210,000 (sulphur) 290,000 (potash) 500,000	-1.21 to -.03*	-0.43 to 0.35*	.03 to .81*	7.05	1.90	-10.16 to -8.98*	-9.38 to -8.60*	-8.92 to -8.14*

* Range of values, actual value depending upon the total railway charge for the part of the rail movement having a backhaul. The left-hand value in the range assumes that the railway charges 1.8 times the normal one-way loaded rate for the two-way journey with backhaul, while the right-hand value assumes that the railway charges 1.2 times the normal one-way loaded rate for the two-way journey with backhaul.

** Estimated annual capital cost for Churchill line upgrading to accommodate conventional hopper and gondola cars, based on an assumed volume of 750,000 tonnes per year of grain movement in addition to the other bulk commodity movements, and using an average value of the low and high capital costs ($17,500,000 and $35,000,000) estimated for refurbishing the line.

would result in a loss of $29 to $30 per tonne. For most of the other schemes considered, movement through Churchill would be on the order of $5 to $12 per tonne more expensive than movement through Vancouver.

It should be pointed out that these costs have included, for those options requiring the movement of year round shipment volumes through the Port of Churchill, the increased interest cost of carrying inventory because of the Churchill season, but do not include any costs for the physical storage of these increased inventories.

In Chapter 3 the potential impacts of a longer season on the inventory carrying costs was investigated. It can be seen that the potential reduction in interest costs on additional inventory caused by shipping through Churchill with a 17 week season rather than a 12 week season, on a per tonne basis, is less than the cost disadvantage via Churchill. Therefore a longer season would not result in overcoming the estimated cost disadvantages of Churchill for any of the schemes.

It should also be noted, however, that the terminal and line refurbishment costs for Churchill used in the final cost comparisons correspond to the current volumes of sulphur, potash and phosphate rock shipped to/from the Prairie provinces from/to the origins and destinations stated for each scheme. If these movements were to grow substantially in the future, the relative economics of handling them through Churchill would improve somewhat because per tonne terminal and line refurbishment costs at Churchill would drop due to economies of scale (unit terminal charges at Vancouver might also drop but to a lesser extent because the Vancouver facilities already handle large volumes). For example, if total sulphur exports to Europe and the USSR were to double from the current level of about 850,000 tonnes per year to 1,700,000 tonnes per year so that 425,000 tonnes per year (1/4 x 1,700,000) might be available for handling through Churchill during its current shipping season, the terminal cost at Churchill for commodity Scheme 3B (sulphur to Europe and the USSR and potash to South America with year-round rail shipment of potash to Churchill) would decrease from $7.05/tonne to $5.15/tonne and the line refurbishment cost from $2.90/tonne to $2.10/tonne, making Scheme 3B appear equally economic through Churchill and Vancouver.

Our discussions with representatives of the sulphur, potash and phosphate rock industries, however, have shown that the export/import movements considered are expected to remain fairly stable in the foreseeable future.

Therefore, while it will be important to monitor patterns in the exports and imports of these commodities in the future to identify changes that might affect the relative competitiveness of handling them through Churchill, the outcomes of the comparisons in Exhibit 5.3, which show that use of Churchill for additional bulk commodities is not economic, are expected to remain valid for the foreseeable future.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

Essentially the conclusions of this study are negative in that no commodity was found to be more economic as a movement through the Port of Churchill than through existing export or import channels (Vancouver in most cases) when all costs were taken into account, including:

- expected railway rates for the movement of bulk commodities;
- railway car ownership costs;
- additional Churchill railway line costs needed to upgrade the line to accept conventional rail cars;
- actual terminal charges at Vancouver and estimated terminal charges at Churchill;
- ocean freight rates.

Of all the potential movements through Churchill, the one that comes closest to being economic is a combination of the movement of sulphur from Alberta to Europe and to the USSR during the Churchill navigation season, with potash moving from Saskatchewan to Brazil in year-round quantities by stockpiling either at the mine or at Churchill. It should be noted, however, that in this comparison, although the interest charges of carrying year round inventory for the potash have been included in the comparison, the actual physical storage costs have not.

If the investment for refurbishment of the Churchill line to accept standard railway hopper cars is excluded from the equation, then in two of the three freight rate scenarios the Churchill route would appear to be marginally economic for this movement. This is a very tenuous conclusion, however, based as it is on a number of assumptions favourable to Churchill including:

- this movement would not be charged any of the cost of upgrading the line;
- railway bulk freight rates on the Churchill route can be lowered to a level similar to those on other, main line routes to Vancouver;
- no additional physical storage costs need to be included for the storage of potash beyond those required for the transfer between rail and vessel;
- a rate of return of 11 percent would be sufficient for the terminal facilities. This before tax rate of return is comparable to those required for public investments but is probably insufficient for private investment in facilities.

All in all, therefore, specific steps for new investment in Churchill are not justified at this time. Such investment could, of course, become justified at some point in the future due to new technology, the development of new commodity movements to/from points located relatively near Churchill and/or major changes in the volumes and origin/destination patterns of existing bulk commodity movements.

6.2 RECOMMENDATIONS OF THE STUDY TEAM

Based upon these findings, the study team makes the following recommendations:

1. The various shippers of bulk materials in Western Canada, particularly those of sulphur and potash, should be kept informed of the potential of the Port of Churchill for their use. They should be encouraged to investigate alternative schemes for handling bulk materials through this Port in the light of changing circumstances.
2. New developments in commodity movements should be monitored in order to determine if there are major changes in the volume or origin/destination patterns of

commodity movements (such as increased sulphur volumes to Europe) that might improve the competitiveness of Churchill or if there are new commodity movements which might be developing which potentially could move through the Port of Churchill. Examples of the latter are the development of the forest industry in Northern Manitoba and the construction of an aluminum smelter in Manitoba, particularly if it is located in Northern Manitoba. With regard to the proposed aluminum smelter, it should be noted that the Federal and Manitoba Governments have recently initiated a study of the transportation requirements of such a development.

3. Results of this study should be circulated to the various industries and their comments solicited.

4. The review of the changes in the environment that might lead to a more fruitful use of Churchill should be made at least once every three years. It would be desirable that these reviews be conducted jointly by the Province of Manitoba and the Government of Canada. This review would, of course, take into account any changes in government policy and funding regarding Churchill and its rail line, as discussed more fully in the Study D report.

5. As noted earlier, if results of a parallel project under the Canada-Manitoba Subsidiary Agreement on Churchill indicate that the economics of using articulated hopper cars on the Churchill line versus refurbishing the line to take conventional hopper cars are about equal, consideration should be given to the line refurbishment option since this would better leave open the option of future movement of additional commodities through the Port of Churchill.

The Province of Manitoba may wish to consider setting up a special group or a Northern Development Corporation (e.g. a crown corporation), either on its own or in cooperation with the Government of the Northwest Territories, to facilitate and encourage Arctic resupply activities through the Port of Churchill, as discussed more fully in the Study C report. If this course of action is followed, the above monitoring and "marketing" activities regarding future use of the Port for additional commodities could also be taken on by the same group or corporation.

APPENDIX A

ADDITIONAL DESCRIPTIVE MATERIAL ON THE MOVEMENT OF SELECTED BULK COMMODITIES

GRAIN

THE POSSIBILITY OF EXPANDING GRAIN SHIPMENTS THROUGH THE PORT OF CHURCHILL

In recent years the Port of Churchill has been used to considerably less than its capacity for the movement of grain. This failure to fully utilize the Port of Churchill could have occurred for one of several reasons:

- the costs of moving grain through Churchill are greater than via other routes;
- grain buyers and ship owners have shown a reluctance to use Churchill;
- the pattern of origins and destinations of the various types of grain does not favour the use of the Port of Churchill.

All of these possible reasons are investigated in more detail in Study D. The third possible reason is investigated as well in this short paper.

Table 1 shows the volume of grain grown in the hinterland of Churchill, that is the approximate area from which it is cheaper to ship by rail to the Port of Churchill than to alternative ports. This comprises an area in Northern Saskatchewan plus a small area in Northern Manitoba. The crop districts used are shown on Map 1.

Table 1 shows that the main grain crops grown in this area are wheat, barley, rapeseed, oats and durum wheat. Table 1 also shows the total production of grains for the Prairies. It can be seen that the Churchill rail rate advantage area comprises a significant proportion of the total Prairie production for several of these grains, particularly wheat, barley and rapeseed.

Table 2 shows the total volume of grain exports to Atlantic and Mediterranean destinations. Comparing Tables 1 and 2 leads to the following tentative conclusions for each of the grains:

Grain	Comment
Wheat	Wheat is a leading candidate for shipment through Churchill with very significant volumes grown in the Churchill tributary area and very significant volumes shipped to European destinations. In recent years Churchill has been used mainly to ship low grade feed wheats rather than high grade milling wheats shipped before the protein grading system was introduced in 1972.
Durum	Durum might also be a possibility for shipment through Churchill although the volumes grown in the Churchill tributary area are relatively small, between 300 and 400 thousand tonnes per year.
Oats	Oats are not generally exported to European destinations.
Barley	Barley is also a good candidate with significant volumes being grown in the Churchill tributary area and significant volumes being exported to Atlantic destinations.
Rye	Rye is not a good candidate with low volumes grown in the Churchill area and low volumes shipped to European destinations.
Flaxseed	Relatively low volumes are grown in the Churchill tributary area.
Rapeseed	While high volumes are grown in the Churchill tributary area, only relatively low volumes are shipped to European destinations. These volumes are usually in relatively small shipment sizes as well.

It is interesting to note that while grain exports to Europe and North Africa have more than doubled over the last decade, Churchill shipments have not been growing. Table 1 also shows the volume of grain shipped through the Port of Churchill.

SUMMARY

This brief analysis of the movement of grain through the Port of Churchill indicates that wheat and barley are the main possibilities. These, of course, are the two grains that the CWB has been moving through Churchill. Rapeseed might move through the Port of Churchill in single ship load lots although such shipment may be difficult to put together in Churchill. No other grains, with the possible exception of durum wheat, seem to offer the same possibilities.

Table 1

Total Grain Production in Crop Districts Lying Within the Churchill Rail Rate Advantage Area*: 1982-1984

	PRODUCTION ('000 TONNES)									SHIPPED THROUGH CHURCHILL		
YEAR	Spring Wheat	Durum Wheat	Winter Wheat	Oats	Barley	Rye	Flaxseed	Rapeseed	Total	Wheat	Barley	Total
1982	6,533	379	26	542	2,626	172	128	731	11,137	389	168	557
1983	6,234	361	37	381	1,792	143	69	364	9,381	22	571	593
1984	4,945	312	89	335	2,001	122	166	1,297	9,267	428	8	436
Total Grain Production for Manitoba, Saskatchewan and Alberta: 1982-84												
1982	22,720	3,121	286	2,837	12,584	832	752	2,168	45,300			
1983	22,393	2,620	414	2,098	9,101	721	444	2,529	40,320			
1984	17,538	2,085	463	1,912	9,036	563	693	3,288	35,578			

* Includes the following crop districts:

Manitoba	5
Saskatchewan	5b, 6b, 7a, 7b, 8a, 8b, 9a, 9b

Source: Statistics Canada Acreage, Yield and Production Figures

Table 2

Grain Exports to European* Destinations

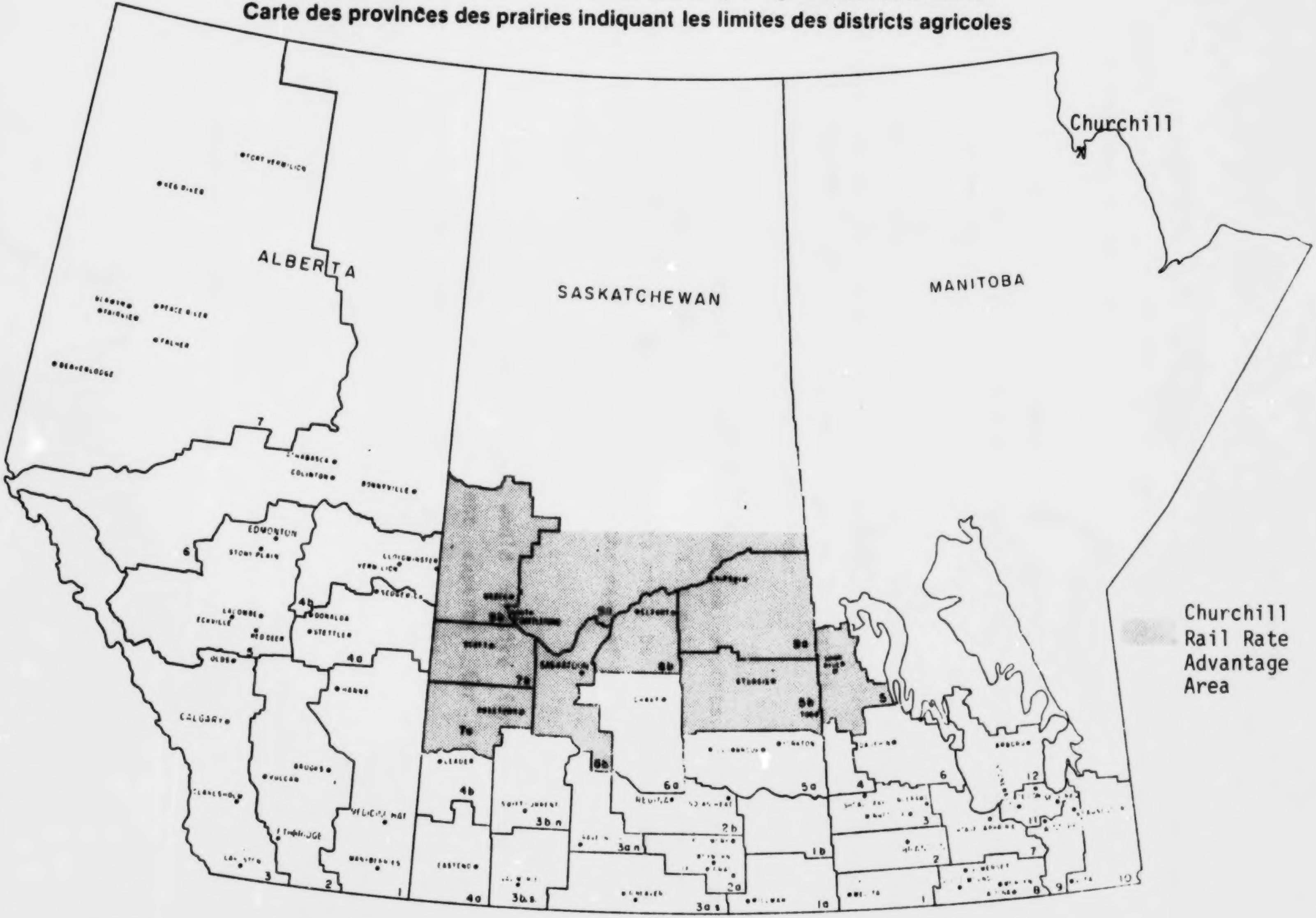
	('000'S TONNES)							
YEAR	Wheat	Durum Wheat	Oats	Barley	Rye	Flaxseed	Rapeseed	TOTAL
1973/74	3,317	1,242	-	1,439	52	270	105	6,425
1974/75	2,589	1,387	5	1,466	67	216	35	5,765
1975/76	4,913	1,559	260	2,498	225	95	22	9,572
1976/77	4,664	1,634	450	2,249	52	219	232	9,500
1977/78	5,684	1,943	44	2,066	183	154	96	10,170
1978/79	3,946	1,334	4	2,168	46	366	511	8,375
1979/80	5,638	1,914	73	2,407	362	318	550	11,262
1980/81	6,375	1,991	42	2,202	425	348	118	11,501
1981/82	7,970	2,226	20	4,020	522	255	77	15,090
1982/83	8,456	2,547	6	3,630	115	269	101	15,124
1983/84**	8,546	2,407	-	3,353	81	396	323	15,106

* Including U.S.S.R. and Mediterranean Ports in North Africa
** Preliminary Figures.

Source: Canada Grains Council, Statistical Handbook 1984

MAP 1

Outline Map of the Prairie Provinces Showing Crop District Boundaries
Carte des provinces des prairies indiquant les limites des districts agricoles


Churchill
ALBERTA
SASKATCHEWAN
MANITOBA
EDMONTON
CALGARY
7
6
5
4a
4b
3
2
1
7a
7b
9a
9b
8a
8b
6a
6b
5a
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2b
1a
1b
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8
9
10
11
12
Churchill
Rail Rate
Advantage
Area

COAL

EXPORTS OF COAL FROM ALBERTA, AND THE POSSIBILITY THAT SOME MIGHT BE SHIPPED THROUGH CHURCHILL

Alberta's coal production has more than doubled during the past decade. About 1/3 of it is bituminous, of which about 60 percent is exported (see Tables 1 and 2).

During the past 5 years total exports have fluctuated but averaged a little less than 5 million tonnes with an estimated current value exceeding $200 Million.

Most exports are to Pacific rim countries, but in 1984 over 750,000 tonnes were exported to West Germany, France, Benelux and Brazil. It is possible that some of this might be shipped through Churchill if transportation costs and timing were propitious.

Table 3 summarizes total Canadian coal exports. The table has been arranged to present this data in a similar fashion to that for Albertan exports and suggests that Alberta might be able to increase its exports to some of these countries to the east of it and even possibly through Churchill.

That such a possibility would require further study is illustrated in Table 4 showing current exports (for 1983) to these countries from both Sydney, Nova Scotia, and Vancouver.

Sources:
Export Data: Statistics Canada - Canada
- Alberta, Publication 26-206 supplemented by telephone calls

Port Handling: Statistics Canada

TABLE 1

COAL PRODUCTION IN ALBERTA

(THOUSAND TONNES)

	Bituminous	Sub-Bituminous	Total
1974	3312	5075	8387
1975	4098	5958	10056
1976	4583	6409	10992
1977	4289	7725	12014
1978	5115	8278	13393
1979	5529	9575	15104
1980	6852	10544	17396
1981	6895	11551	18446
1982	6978	13021	19999
1983	7315	14564	21879
1984	7630	15421	23051

TABLE 2

ALBERTA COAL EXPORTS

(THOUSAND TONNES)

	USA	JAPAN	S.KOREA	W.GERMANY	FRANCE	BENELUX	BRAZIL	OTHER	TOTAL
1980	--	3546	---	---	---	---	---	1165	4711
1981	--	3022	---	---	---	---	---	1117	4139
1982	253	4165	---	---	---	---	---	847	5265
1983	9	4321	91	382	---	---	313	---	5116
1984:									
Thermal:		106	---	334	55	---	---	---	N/A
Metallurgical:		3679	283	---	---	101	277	---	N/A
Total:		3785	283	334	55	101	277	---	4835

TABLE 3

TOTAL CANADIAN COAL EXPORTS

(THOUSAND TONNES)

	USA	JAPAN	S.KOREA	W.GERMANY	FRANCE	BENELUX	BRAZIL	U.K.	DENMARK	SWEDEN	PAKISTAN	YUGOSLAVIA	CHILE	EGYPT	NETHERLANDS	GREECE	OTHER	TOTAL
1982	79	10966	1987	727	---	13	302	---	216	271	153	-----	51	---	93	--	670	15528
1983	179	10997	2357	779	---	26	716	---	296	218	139	-----	120	---	165	29	953	16974
1984	172	15880	3252	391	525	324	1206	133	325	245	156	119	172	35	116	71	1232	24354

TABLE 4

VOLUMES OF COAL REPORTED HANDLED BY TWO PORTS IN 1983

(THOUSAND TONNES)

TO:	W.GERMANY	BENELUX	BRAZIL	DENMARK	SWEDEN	NETHERLANDS	GREECE
THROUGH							
SYDNEY, NOVA SCOTIA	158	26	240	---	118	225	29
VANCOUVER	438	--	682	349	103	---	--

FOREST PRODUCTS

THE POSSIBILITY OF EXPORTING MANITOBA PRODUCED LUMBER, PULP OR PAPER PRODUCTS THROUGH CHURCHILL

Today there are approximately 1 million cunits (cords per year) of forest resources in Northern Manitoba which are not being utilized. If they were utilized the products might be exported through Churchill. Approximately half of these are unleased in the Hayes River area. The other half is in the Nelson River area, which is currently leased to ManFor, a crown corporation operating out of the Pas, but which is currently surplus to existing requirements. The Government is currently re-examining the leases to ManFor and might reallocate them, making this timber available to others.

ManFor is also available for sale. A previous potential bidder for the company was going to increase the capacity of the current mills and ship some of the production to Europe. The bidder was Repap but this company subsequently purchased a mill in New Brunswick.

The main product of the ManFor operation is unbleached paper which is shipped in rolls. One million cunits would produce approximately 1 million tonnes of newsprint or 500,000 tonnes of pulp per year.

The main market for ManFor is the West and Mid-West of the United States. Products are currently mainly shipped by rail. The value of newsprint is between $300 and $500 per tonne, making inventory holding expensive and probably making it impossible to rely on Churchill solely.

The following points summarize the argument that there may be some potential for the further development of the forest industry in Northern Manitoba:

- although there is a surplus of softwood timber world demand is going up;
- there are at present no plans to develop this resource but it is a resource which is increasing in scarcity;
- employment is required in Northern Manitoba;

- if development does occur in Northern Manitoba, the use of the Port of Churchill is possible.

According to Manitoba Natural Resources the Statistics Canada categories of products which might be produced in this area and therefore exported are:

- lumber - spruce, pine, fir;
- pulp - sulphate, unbleached paper grade
  - sulphite, unbleached newspaper grade;
- paper - newsprint and unbleached kraft.

The pattern of present Canadian exports of each is given in Tables 1, 2, 3 and 4, covering the six years 1979-84.

No companies are at present exporting through Churchill and no companies have expressed an interest in doing so; therefore our comments naturally have to be of a general and speculative nature.

The principal matters displayed by the tables are that:

1. During the last six years the volume of:
   - these lumber exports have increased almost 45 percent during the last two years, being static before that; and now equal $2 1/2 billion per year;
   - for the types of pulp likely to come from the area, exports have declined:
     - sulphate by over 35 percent, to $70 million per year;
     - sulphite by almost 90 percent, to $1/4 million per year;
   - newsprint has remained fairly static at around 8 million tonnes per year, currently amounting to about $4 1/2 billion.

2. The United States purchases over 90 percent of these lumber and 80 percent of newsprint exports, so that the pattern of their purchases has naturally determined that of the total of these Canadian exports.

   Apart from being largely in the wrong geographic direction, individual components of these U.S.-Canada exports are likely to be confirmed by ownership patterns, as well as being traditional. Assuming reasonable continuity of supply as well as of purchases it might be difficult for Manitoba product to secure more than a very small share of these exports.

   The pattern of exports to other countries has been more volatile and might well permit some entry of Manitoba product over the long term, provided other conditions were right.

3. Reduced sales to the United States have been a major factor contributing to the decline of sulphite pulp exports but even those to other countries have declined, althought not to the same extent. The decline in sulphate exports has been moderately uniform to all countries, including the United States.

SUMMARY

Manitoba has forest resources which at present are under-utilized. Over the long term it is very probable that these resources will be developed.

The current patterns of trade in those products which might be produced in Northern Manitoba show a heavy reliance on North American markets. Those products which are exported overseas vary considerably from year to year. It is possible that, over the longer term, an industry will be set up in Northern Manitoba and the companies will establish overseas trading patterns but this is by no means certain. The use of Churchill for the exports of the forest industry therefore may be possible at some time but, as of now, these are no positive indicators.

Table 1

Canadian Trade in Spruce, Pine, and Fir Lumber
(thousands of cubic metres)

TO	1979	1980	1981	1982	1983	1984
United States	15,785	14,713	14,691	15,446	20,512	23,165
United Kingdom	1,024	1,106	1,004	863	875	883
Saudi Arabia	50	99	211	370	408	230
Japan	177	285	184	240	280	281
France	123	320	267	186	117	144
Egypt	28	195	115	170	118	99
Algeria	13	55	49	16	48	45
65 Other Countries	311	628	509	342	170	276
Total	17,511	17,401	17,030	17,633	22,528	25,123
Value $mm	1,812	1,622	1,582	1,579	2,290	2,523

Source: Statistics Canada Item 33146

Table 2

Canadian Trade in Sulphate Unbleached Paper Grade Pulp
(thousands of tonnes, air dried)

TO	1979	1980	1981	1982	1983	1984
United States	159.9	132.8	155.0	126.8	117.2	100.1
Australia	14.7	15.9	21.9	19.8	17.7	9.3
Japan	24.3	25.3	20.8	20.0	5.0	8.5
Algeria	5.8	1.9	-	2.0	-	6.0
China	8.9	6.0	4.0	11.7	8.6	5.0
United Kingdom	8.2	13.1	9.7	6.3	3.8	4.6
Thailand	3.8	2.8	4.2	3.0	1.9	4.5
21 Other Countries	22.5	12.4	71.0	45.4	5.5	17.6
Total	248.1	210.2	286.6	235.0	159.7	155.6
Value $mm	101	109	158	123	63	77

Source: Statistics Canada Item 34035

Table 3

Canadian Trade in Sulphite, Unbleached Newsprint Grade Pulp
(tonnes, air dried)

TO	1979	1980	1981	1982	1983	1984
United States	3,420	1,875	1,121	797	311	52
India	-	544	1,000	-	-	499
West Germany	271	-	576	363	-	-
Italy	1,022	-	-	-	217	-
United Kingdom	-	66	-	-	-	-
Belgium, Luxemburg	61	-	-	-	-	-
Netherlands	217	-	-	-	-	-
Total	4,991	2,485	2,697	1,160	528	551
Value $m	1,768	1,241	1,291	557	256	309

Source: Statistics Canada Item 34045

Table 4

Canadian Trade in Newsprint Paper
(thousands of tonnes)

TO	1979	1980	1981	1982	1983	1984
United States	6,348	6,208	6,164	5,579	5,949	6,692
United Kingdom	399	434	554	503	503	389
Venezuela	88	100	117	100	108	103
West Germany	82	78	93	88	73	97
Australia	127	152	103	63	39	75
India	114	96	143	60	38	79
Japan	19	16	29	11	19	68
China	58	52	77	26	14	65
Colombia	59	57	87	67	57	61
Brazil	94	102	96	93	78	56
Puerto Rico	40	32	44	45	45	45
66 Other Countries	350	391	478	446	456	402
Total	7,778	7,718	7,985	7,081	7,379	8,132
Value $mm	3,222	3,684	4,525	4,086	3,956	4,784

Source: Statistics Canada Item 35109

SULPHUR

THE POSSIBILITY OF EXPORTING SULPHUR THROUGH THE PORT OF CHURCHILL

Sulphur is a growing export commodity for Canada. Table 1 shows total Canadian trade in recent years.

In Canada sulphur is produced mainly by the refining of sour natural gas. In addition some elemental sulphur is produced as a by-product of the refining of oil. At the end of 1983 Canadian sulphur production capacity by province, expressed in tonnes per day, was as follows:

	Sour Gas Plants	Oil Refineries
Alberta	26,877	96
B.C.	1,560	50
Saskatchewan	7	-
Ontario	-	231
Quebec	-	389
New Brunswick	-	200
Nova Scotia	-	76
	28,444	1,042

Sulphuric acid and sulphuric dioxide are also produced as a by-product of the refining of metals, mainly in B.C., Ontario and Quebec.

According to the Canadian Minerals Yearbook "sulphur production in Alberta peaked in 1973 at 7 million t, and has since been declining, mainly for two reasons: (i) sour gas pools have been generally replaced by sweeter gas pools; (ii) natural gas production and sales have been stagnant since 1973. Production of sulphur in Alberta however, has always exceeded Canadian sales during the 1970s, and as a result inventories have accumulated and reached a peak of 21.3 million t in 1980. Sales have exceeded production since 1980 and inventories have been drawn down at a rate averaging 2.15 million tpy. At this rate inventories should be depleted in the late 1980s or early 1990s unless sour gas production in Canada increases substantially or high sulphur gas fields in southwestern Alberta are developed."

There are some rail exports of sulphur to the United States. Almost all marine exports pass through the Port of Vancouver. Table 2 shows the distribution of these marine exports in 1983 and 1985. It can be seen that significant volumes are destined to Atlantic and Mediterranean ports. Summarizing Table 2, total exports through Vancouver were as follows:

Destination	Tonnes 1983	 1985
Atlantic Ocean	2,913,873	3,800,864
Pacific and Indian Oceans	1,773,318	2,322,412
Total	4,687,191	6,123,276

The long rail distances from the main sources of production in Alberta are the main drawback to the use of Port of Churchill for major sulphur movements. One sulphur shipper, Amoco, did in fact ship sulphur through Churchill when it could not achieve sufficient capacity through the Port of Vancouver. It stopped this movement because:

- capacity became available in Vancouver;
- CN raised the rail freight rate.

The current discussions with shippers did not indicate any desire to investigate the use of the Port of Churchill. They appear to be satisfied with their current export channels through Vancouver.

SUMMARY

Although this brief analysis indicates that there may be some problems associated with shipping sulphur through the Port of Churchill, the high degree of Atlantic orientation of this trade must make it a candidate.

TABLE 1

CANADIAN SULPHUR SHIPMENTS AND TRADE, 1982-84

	1982		1983		1984P	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Shipments						
Pyrite and pyrrhotite[1]						
Gross weight	20 000	..	-	-	-	-
Sulphur content	9 000	220	-	-	-	-
Sulphur in smelter gases[2]	627 000	42,027	678 286	42,322	874 906	63,300
Elemental sulphur[3]	6 945 000	569,928	6 631 123	427,358	7 700 455	574,177
Total sulphur content	7 581 000	612,175	7 309 409	469,680	8 575 361	637,477
Imports					Jan.-Sept. 1984	
Sulphur, crude or refined						
United States	2 159	395	2 353	653	2 341	639
Other countries	-	-	12	3	4	1
Total	2 159	395	2 365	656	2 345	640
Sulphuric acid, including oleum						
United States	74 262	4,847	116 567	8,353	22 768	2,122
West Germany	74 405	2,480	7 484	248	3	-
Norway	22 390	913	2 522	172	-	-
Other countries	21 457	840	-	-	10	10
Total	192 514	9,080	126 573	8,952	22 781	2,132
Exports					(Jan.-Sept. 1984)	
Sulphur in ores (pyrite)						
West Germany	-	-	..	63	-	-
United States	..	239	..	14	..	34
Japan	-	429	-	-	-	-
Total	..	668	..	77	..	34
Sulphuric acid, including oleum						
United States	259 716	8,404	250 061	7,744	-	-
Other countries	24	20	11	3	22 984[4]	892
Total	259 740	8,424	250 612	7,747	22 984	892
Sulphur, crude or refined, nes						
United States	1 132 352	85,510	1 112 860	76,797	1 270 171	93,204
Brasil	447 439	60,621	573 145	66,071	323 855	40,797
Morocco	464 889	61,544	358 735	40,153	270 455	33,689
Tunisia	349 830	45,432	310 095	38,261	227 173	30,133
South Africa	453 336	59,748	366 640	38,079	394 812	44,322
Australia	467 268	58,234	364 448	37,878	327 473	37,781
South Korea	194 236	26,058	296 146	33,168	258 830	30,661
People's Republic of China	309 906	41,449	217 027	24,183	189 651	20,841
U.S.S.R.	201 086	27,628	198 075	21,890	136 800	15,596
Finland	96 758	13,303	179 732	21,880	124 572	14,254
India	373 239	43,172	218 170	18,298	150 185	18,783
Israel	152 773	10,802	226 517	18,092	192 462	18,211
Taiwan	125 922	17,638	152 825	16,248	140 741	15,949
Netherlands	53 603	7,223	149 151	15,672	142 787	15,543
France	51 029	7,022	122 754	15,167	71 561	8,577
New Zealand	208 410	25,864	158 021	15,114	163 291	19,500
Other countries[5]	1 029 368	128,581	665 934	75,329	816 384	98,104
Total	6 111 444	719,829	5 670 275	572,280	5 201 203	556,021

Source: Statistics Canada; Energy, Mines and Resources Canada.

[1] Producers' shipments of byproduct pyrite and pyrrhotite from the processing of metallic sulphide ores. [2] Sulphur in liquid SO_2 and H_2SO_4 recovered from the smelting of metallic sulphides and from the roasting of zinc-sulphide concentrates. [3] Producers' shipments of elemental sulphur produced from natural gas; also included are small quantities of sulphur produced in the refining of domestic crude oil and synthetic crude oil. [4] Netherlands and Switzerland. [5] Mainly Belgium-Luxembourg, Senegal, Indonesia, Argentina, Chile, Cuba, and Mozambique.

P Preliminary; - Nil; .. Not available; nes Not elsewhere specified.

Taken from Canadian Minerals Yearbook, 1983-84

TABLE 2

SULPHUR EXPORTS THROUGH THE PORT OF VANCOUVER

DESTINATION	TONNES 1983	TONNES 1985
France	124,099	76,585
Belgium-Luxemburg	137,700	241,183
Netherlands	242,659	364,358
United Kingdom	22,000	-
Finland	187,450	147,623
USSR	155,764	233,105
Romania	37,000	45,794
Black Sea Nes	65,636	-
Israel	194,444	32,331
Tunisia	287,126	380,658
Morocco	358,120	818,300
Mozambique	64,673	-
South Africa	388,464	444,320
Bangladesh	51,700	26,914
India	202,850	503,266
Indonesia	83,620	200,779
Hong Kong	16,500	-
Japan	20,985	40,180
Korea South	286,376	503,108
People R. China	237,217	142,807
Taiwan	139,464	120,298
Thailand	12,450	442,086
Australia	418,043	415,811
New Zealand	157,740	159,962
Argentina	100,251	24,232
Brazil	511,688	522,552
Chile	74,200	91,373
Panama	7,500	-
Cuba	57,650	114,494
US Atl & Gulf	43,822	5,715
Other Africa	-	65,353
Algeria	-	17,811
Italy	-	177,828
Malaysia	-	10,549
Pakistan	-	9,597
Peru	-	1,470
Philippines	-	33,000
Other South America	-	1,480
Senegal	-	88,622
Viet Nam	-	9,027
Total Handling Port	4,687,191	6,123,276

Source: Vancouver Port Corporation Statistics.

APPENDIX B

COST ANALYSIS OF EXPORTING NORTH DAKOTA CORN THROUGH CHURCHILL

APPENDIX B

COST ANALYSIS OF EXPORTING NORTH DAKOTA CORN THROUGH CHURCHILL

The Terms of Reference for Study B specifically include consideration of the drying at and export from Churchill of corn produced in North Dakota and Minnesota. In order to examine the feasibility of this potential movement, a rate comparison has been carried out for moving corn from North Dakota to export markets in Europe for four alternative routes: via rail to Minneapolis/St. Paul and barge down the Mississippi River to the U.S. Gulf; via rail to the Port of Duluth and the St. Lawrence system; via rail to Thunder Bay; and via rail to Churchill.

The results of the rates comparison are given in Exhibit B.1. For the purpose of analysis, we have considered unit train movements of corn originating in Fargo, North Dakota. Fargo is located in the southeastern part of the state on the main Burlington Northern Line running between Winnipeg and Minneapolis/St. Paul. The only alternative route from North Dakota to Churchill would make use of the BN or Soo Line from Minot into southeastern Saskatchewan. However, very little corn is grown in the northwest part of the state, with the main production being in the southeast corner.

In examining the rail movement within Canada for the two Canadian routes (Churchill and Thunder Bay), two different rates have been used. The first is the full grain rail rate payable to the railways under the Western Grain Transportation Act. The second is the full grain rate minus a discount of $3.00 per tonne that might be offered by the railways to reflect cost savings associated with unit train operations. The value of $3.00 per tonne is based on the discounts recently proposed by CN for multiple car shipments of non-Board grain loaded on a main line (this proposal was subsequently withdrawn) and the percentage discounts offered by Burlington Northern for 54 car unit train relative to single car

EXHIBIT B.1

CURRENT (1985) RATE COMPARISON (EX COUNTRY ELEVATOR) FOR CORN FROM NORTH DAKOTA TO EUROPE VIA A U.S. GULF PORT, DULUTH, CHURCHILL AND THUNDER BAY

(all rates in $Can./tonne)

i) U.S. GULF ROUTE

B.N. unit train (54 car) rate from Fargo, ND to St. Paul, MN	15.00
Transshipment to barge at St. Paul	4.00
Barge rate from St. Paul to New Orleans	15.00
Terminal elevator at New Orleans	6.50
Ocean Freight	9.00
TOTAL	$49.50

ii) DULUTH ROUTE

	Via St. Lawrence Port	Direct Overseas
B.N. unit train (54 car) rate from Fargo, ND to Duluth, MN	15.00	15.00
Terminal elevator at Duluth	7.50***	7.50***
Lake transportation	16.00	-
Transfer elevator	5.08	-
Ocean freight	11.00	21.50
TOTAL	$54.58	$44.00

iii) CHURCHILL ROUTE

Unit train (54 car) rate from Fargo, ND to Emerson, Man.**	8.10**	
Total rail rate from Emerson to Churchill	30.35	(27.35*)
Terminal elevator at Churchill	9.00	
Ocean Freight	15.50	
TOTAL	$62.95	($59.95)

EXHIBIT B.1 (Con't)

iv) THUNDER BAY ROUTE

	Via St. Lawrence 'Port		Direct Overseas	
Unit train (54 car) rate from Fargo, ND to Emerson, Man.	8.10**		8.10**	
Total Rail Rate from Emerson to Thunder Bay	20.17	(17.17*)	20.17	(17.17*)
Terminal Elevator at Thunder Bay	7.81		7.81	
Lake Transportation	16.00		-	
Transfer Elevator	5.08		-	
Ocean Freight	11.00		21.50	
TOTAL	$68.16	($65.16)	$57.58	($54.58)

* Full statutory grain rate might be discounted by an estimated $3.00/tonne to reflect rail cost savings associated with multiple car operations.

** Estimated rate based on actual rates charged by B.N. for routes of similar distance.

*** Includes an estimated charge for cleaning that would have to be done elsewhere.

rates. It is possible that CN would want to charge rates for corn to Churchill that would be higher than the full rail rate provided by the WGTA to recover additional variable costs involved in using boxcars or articulated hopper cars on the Hudson Bay line.

The rates comparison indicates that moving North Dakota corn through Churchill is not economically feasible at present. The cheapest route right now, with a total rate of $44.00 per tonne, appears to be through Duluth with direct ocean shipment overseas (using "salties"). The next best alternative route is via the Mississippi River and U.S. Gulf, with a total rate of $49.50 per tonne. Of the remaining Canadian routes, movement through Thunder Bay direct overseas is cheapest ($54.58 per tonne assuming the $3.00 per tonne rail discount is achieved). The estimated total rate for the Churchill route is $59.95 per tonne assuming the $3.00 per tonne CN rate discount and $62.95 per tonne if this discount cannot be obtained. Shipping corn through Churchill, however, would be cheaper than shipping through Thunder Bay using a lake vessel and trans-shipment to an ocean-going vessel at a lower St. Lawrence port under current market conditions.

The rate estimates given here, especially the barge and ocean vessel rates, are subject to significant fluctuation in the future as market conditions change. However, direct overseas ocean freight rates from Duluth would have to increase by 65 percent relative to ocean rates from Churchill, other things being equal, to equalize rates for this route and the Churchill route. Similarly, Mississippi barge rates would have to escalate by 60 percent relative to ocean rates from Churchill to equalize total rates on the U.S. Gulf and Churchill routes. It is highly unlikely that such large relative increases would occur, since ocean and other marine rates from all ports normally rise together roughly in proportion.

Even if the Churchill routing were cheaper for corn producers in North Dakota, it is dubious that Burlington Northern would be interested in carrying export corn to the Canadian border for an estimated rate of $8.10 per tonne when it currently moves that same corn to Duluth and St. Paul for $15.00 per tonne (from Fargo). It is possible that the corn could instead be trucked to the Canadian border, but at a somewhat higher cost (approximately $14/tonne from Fargo to Emerson).

It is possible that the trains carrying corn to Churchill could backhaul urea from the Soviet Union. However, even if this backhaul were to materialize and could absorb half of the unit train rail rate to Churchill used in this example, the Duluth route would still have the cheaper total rate ($44.00 per tonne vs. $46.28 per tonne). Besides, picking up urea from the Soviet Union would involve additional ocean vessel costs (extra sailing time and loading time) not accounted for in the above comparison. The same backhauls as for Churchill could also be achieved on the alternative routes.

In conclusion, using Churchill to export North Dakota corn does not emerge as a feasible possibility.

APPENDIX C

ESTIMATION OF MARINE FREIGHT RATES FROM CHURCHILL AND THUNDER BAY

APPENDIX C

ESTIMATION OF MARINE FREIGHT RATES FROM CHURCHILL AND THUNDER BAY

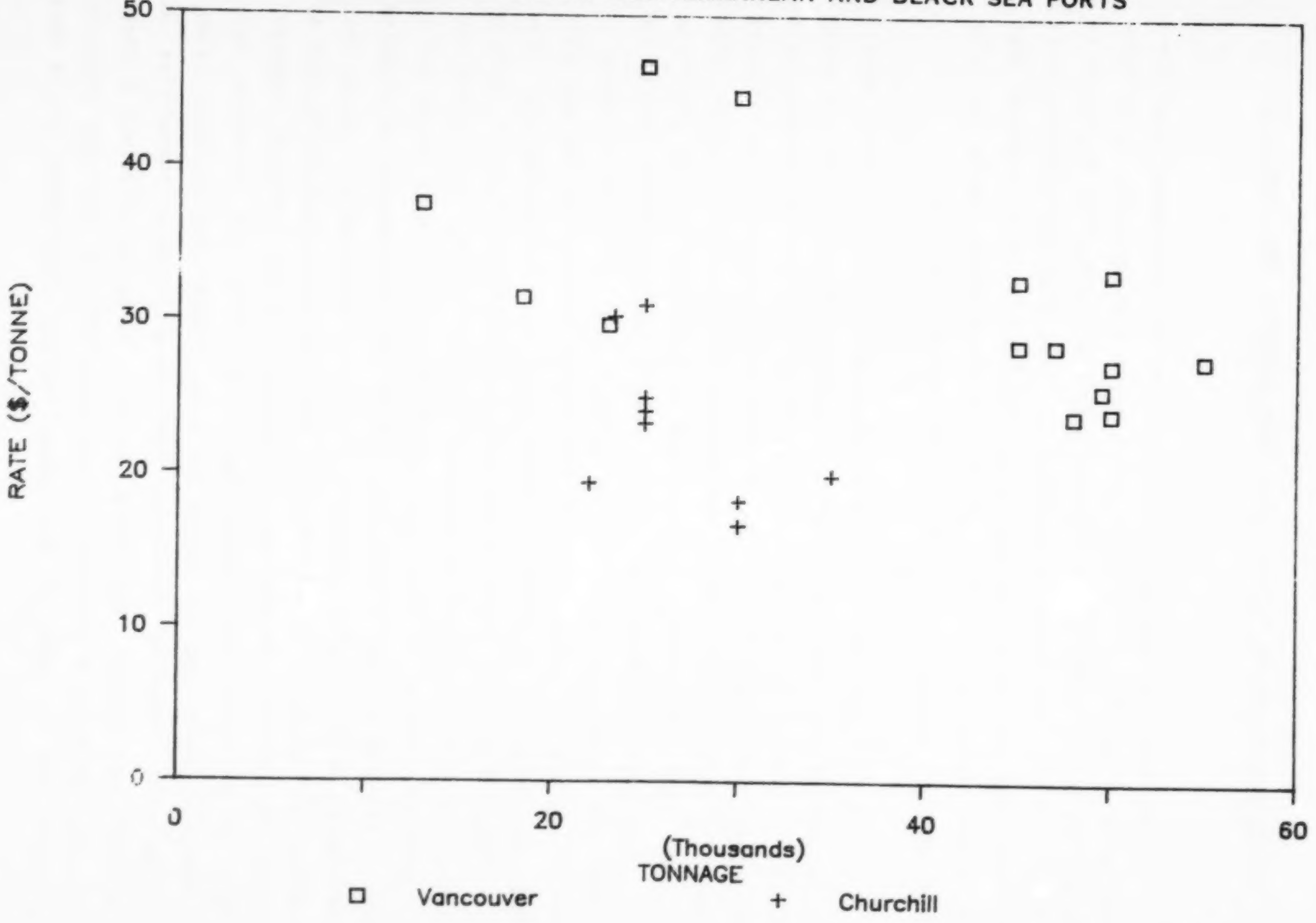
In order to estimate the ocean rates for bulk commodities other than grain from Churchill, the grain rates from Churchill to Northern Africa and Europe were plotted together with grain rates from Vancouver to Northern Africa and Europe in Exhibit C.1. Examining the Vancouver rates for shiploads over 45,000 tonnes, it was found (as would be expected) that the higher rates are for those points in Eastern Europe, while the lower rates represent movements to Western Europe and North Africa.

The average rate to Eastern Europe was found to be approximately 20 percent higher than the average rate to Western Europe and North Africa. In order to correct for potential rate differences between grain and other bulk commodities, the shipping rates for grain from Vancouver (shown in Exhibit C.1) were compared with those for coal from Vancouver for the same ship sizes. This was done by taking the average grain rate from Vancouver to Western Europe for vessels loading greater than 40,000 tonnes and comparing that to the average coal rate for movements to Western Europe in vessels greater than 40,000 tonnes. The average grain rate was found to be $3.90 per tonne higher than the average coal rate. The lower coal rate could be due to several different factors: greater opportunities for backhauls at European and North African ports where coal is unloaded, faster loading and unloading rates for coal versus grain, less likelihood of coal bulking out, and reduced requirements for cleaning the cargo holds between voyages. It is also reasonable to assume that similar savings would be available for other non-grain commodities such as potash and sulphur shipped out of Vancouver. We are convinced, however, that at Churchill and Thunder Bay ocean rates for non-grain bulk commodities would not be $3.90 per tonne cheaper than the grain rates, because the handling facilities for non-grain bulk commodities at Churchill and Thunder Bay would not be as large and efficient as those currently existing in Vancouver. There would still be some rate reduction available due to some of the other factors listed above, and we have

EXHIBIT C.1

GRAIN SHIPPING RATES

TO ATLANTIC OCEAN, MEDITERRANEAN AND BLACK SEA PORTS



SOURCE: 1983 - 1985 CHARTERING ANNUAL, MARITIME RESEARCH INC. U.S.A.

decided to use one-half of the $3.90 difference for Vancouver, that is one-half x $3.90 = $1.95, as the difference between grain and non-grain bulk commodity rates from Churchill and Thunder Bay.

The average grain rate from Churchill to Europe and North Africa based on the nine rates shown in Exhibit C.1 was $23.14 per tonne. Four of the rates from Churchill were to points in Eastern Europe. To obtain a representative rate to Western Europe, three approaches were considered. First, the average of the four rates to points in Western Europe was calculated to be $19.90/tonne. When the single rate from Churchill to Marseilles was included, this average became $22.00/tonne. Finally, when the overall average rate of $23.14 per tonne (for the nine rates) was decreased by four-ninths of the percentage difference found between grain rates from Vancouver to Eastern and Western Europe (4/9 x 20% = 8.9%), the rate reduced to $21.10/tonne. In light of the uncertainties imposed by the small sample size of grain rates from Churchill to Western Europe, we have assumed a value of $21.60/tonne which is a mid-range value with respect to the three different estimates given above. Subtracting the $1.95 per tonne correction for non-grain commodities produces a rate of $19.65/tonne for non-grain bulk commodities shipped from Churchill in a 30,000 tonne vessel.

The average ocean rate from Thunder Bay to Western Europe and North Africa for grain has been calculated as $36.60 per tonne for a 25,000 tonne ship. Thus, subtracting the $1.95 per tonne correction as above the rate used for a non-grain bulk commodity from Thunder Bay is $34.65 per tonne.

As stated in Chapter 3, non-grain bulk commodity ocean freight rates from the three alternative ports of Churchill, Vancouver and Thunder Bay to destinations other than Western Europe have been estimated using the ratios of ocean costs to each destination to ocean costs to Western Europe obtained from the ocean bulk vessel cost model of Appendix D of Study D. This approach assumes that at a given point in time, while the level of ocean rates to various destinations is set by market supply/demand factors, the rates constitute reasonably similar proportions of actual costs for the different voyages. This assumption is supported by the ocean rates and costs presented in Section 3.1 of Study D for grain shipments from Churchill, Thunder Bay and St. Lawrence ports to Northwestern Europe. Below we present a sample calculation, for the ocean freight rate from Churchill to South America, to demonstrate the basic methodology used:

First, the ocean cost from Churchill to Western Europe (Antwerp/Rotterdam) was calculated using the ocean cost model:

Navigating days from Churchill to Antwerp/Rotterdam	= 11 days (one-way)
Cost of return voyage from Churchill to Antwerp/Rotterdam with zero backhaul	= $23.30/tonne

Next, the ocean cost from Churchill to South America (Rio de Janiero) was calculated from the ocean cost model:

Sailing distances from Churchill to Rio de Janiero = 6,736 miles

Sailing days from Churchill to Rio de Janiero $= \frac{6{,}736 \text{ mi.}}{326 \text{ n.mi./day}} = 20.7$ days

Cost of return voyage from Churchill to Rio de Janiero with zero backhaul = $37.56/tonne

Finally, the ocean rate developed above for a non-grain bulk commodity from Churchill to Western Europe of $19.65/tonne is multiplied by the ratio of the ocean costs from Churchill to South America and Western Europe to obtain an estimated ocean rates from Churchill to South America:

Ocean rate from Churchill
to South America = \$19.65 (37.56/23.30) = \$31.70/tonne

The methodology shown above was repeated to estimate the other ocean freight rates required for the comparative cost analysis of additional bulk commodity movements through Churchill, Vancouver and Thunder Bay.

APPENDIX D

HARBOUR REQUIREMENTS ANALYSIS

STEVENSON, HLUCHAN ASSOCIATES LTD.

MARCH, 1986

PORT OF CHURCHILL

STUDY B

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- 1.2 Navigation
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PORT OF CHURCHILL

1.0 Description of Facilities

1.1 Introduction

Churchill is located at 58 degrees 47'N and 94 degrees 12'W, at the mouth of the Churchill River on the west coast of Hudson Bay.

Churchill Harbour is located in the mouth of the River and is bordered on the east by a rocky peninsula, tapering to a blunt point at Cape Merry, and on the west by another rocky peninsula surmounted by Fort Prince of Wales. Eskimo Island, with Eskimo Point at its north extremity, lies north of the last mentioned peninsula.

1.2 Navigation

A lighted fairway buoy, fitted wtih a bell and radar reflector, is positioned 7.0 kilometres northeast of the Harbour entrance. The entrance and fairway through the Harbour are marked by lighted buoys, and the shoal 300 metres NNW of Cape Merry is also marked by a lighted buoy fitted with a bell.

Three sets of light ranges are located onshore on the west side of the River to facilitate entering the Harbour.

Pilotage is compulsory for merchant ships entering or shifting berth in the Harbour. In general, the pilot is transferred near the fairway buoy from the Harbour tug, the W.N. Twolan. Helicopter transfer has been used in the past for late season pilotage that was required by the M.V. Arctic.

There is a small anchorage within the Harbour but it is recommended that large vessels anchor one to 5 kilometres northwest to northeast of the fairway buoy.

The Canadian Hydrographic Service Sailing Directions report that there are three marine/air radio beacons at Churchill. The most powerful is located 12 kilometres east of Churchill; the second is close to the east of the Harbour, and the third lies 9.6 kilometres SSW of the first.

1.3 Harbour (Figure 1-1)

The Harbour entrance northwest of Cape Merry has a low water depth up to 21 metres and a width of approximately 800 metres; this area is subjected to high tidal currents of about two knots on the flood tide and up to 5 knots on the ebb tide. Further upstream the river widens substantially. At a point just south of the main wharf the river is 2.4 kilometres wide and has a maximum natural depth of 4.9 metres. The navigation channel width varies from 350m at the entrance to 200m just north of the main wharf. A major dredging program was completed in 1980, providing a minimum draft of 9.2 metres at low tide. An annual sounding surveying program is being carried out as part of a sedimentation study by a Vancouver Consultant studying the effects of the River diversion. The berths alongside the loading gallery were dredged to provide additional draft of 11.6 metres. This facilitated the topping up of vessels at any tide, so that a vessel is not restricted to complete loading and leave the Harbour on the same high tide. However, the recent sounding survey however indicates sedimentation has taken place and this operation is no longer possible for the deeper draft vessels.

There is water access on all four sides of the main wharf, providing the following berthing arrangements: on the west face are three grain berths, Berths No. 1, No. 2 and No. 3, and two general bulk cargo berths, Dalgleish at the north end and Wolfe at the south (reference Figure 1-2). The north face is usually used by the resupply barges for loading bulk fuels; the east face behind the wharf is used for the winter berths; and the south face is used for bething smaller tugs and work boats.

Depths stated are in metres below Chart Datum, which is at Low Water Ordinary Spring Tide (LWOST). The 1980 charted dredge depths are as follows:

> The 168 metre general cargo berth at the north end of the wharf was dredged to 10.6 metres; the central 240 metres of the grain loading berths were dredged to 11.6 metres; the remaining length of wharf was dredged to 10.0 metres, with a narrow area adjacent to the wharf face 10 metres wide, dredged to a depth

of between 8.5 and 9.8 metres. This berm against the timber crib wharf was created to ensure against undermining. The original 1980 dredging program was to dredge this area down to 11.6 metres. However, during the dredging program it was discovered that this depth would undermine this portion of the wharf. The channel north of the wharf is 74 metres wide and the south half of the channel, which forms a berth at the north end of the wharf, was dredged to 6 metres and the remainder to 3 metres.

The 1985 sounding survey depths are as follows:

The 168m general cargo berth has a minimum depth of 9.5m alongside; the three grain loading berths totalling 518m, with 9.0m to 9.8m depths alongside, and at the south end of the wharf a general cargo berth 157m long with a depth alongside of 9.0m.

The berth at the north end of the wharf is 93m long with a depth alongside of 5.5m. The berth along the south face is approximately 34m long and the water depth decreases rapidly towards shore. The slipway on the east side of the wharf is approximately 34m wide at the entrance between the wharf wall and old marine railway pier, and runs 600m south to the gallery conveyor causeway. The water depth varies from approximately 2m below to 1m above datum at the south end.

The winter berths are formed between the wharf and shore in the slip north of the conveyor causeway. The inner basin or berth is formed by an earth dike extending from shore across to the wharf just north of the transit shed, the south end being sealed by the causeway. The berth is approximately 260m long, along the wharf wall and 110m wide along the dike. An access road to the basin bottom is located on the east or shore side of the basin. In 1978 concrete pads and pedestals were constructed on the basin bottom to facilitate repair work and inspection of the barges and tug as required. The dike is fitted with a culvert and gate to empty the basin, a small amount of water is usually in the basin over the winter (largely due to seepage) and a yearly operation to break the vessels from the ice is required in the spring using backhoes and other equipment.

The outer basin is formed by a second dike some 150m further north.

The depth of the basin is approximately 0m and accommodates the Harbour tug, the W.N. Twolan, by tying up along the wharf. The Twolan which has a round bottom, common with seagoing tugs, is not free standing and must winter tied to the wharf. (See Figure 1-2)

1.4 Adjacent Land Areas

The land immediately north of the wharf is owned by Ports Canada, and the main portion of Cape Merry Peninsula north of the Ports Canada property is owned by Parks Canada and contains some historic monuments.

North of the wharf is an area of tidal flats rising up a sandy beach towards shore. The flood zone represents an area of 5.2 hectares, running north 315 metres from the wharf end to the Cape Merry Peninsula, and east from the face projection to the rail lines. This 5.2 hectares represents reclaimable land, excluding the channel and winter berth areas. The water depth ranges from 0 to 7 metres above LWOST.

The area south of the Churchill wharf also consists of tidal flats. They extend from the wharf's edge upstream at least 10 km, and they vary in width from 60 metres just south of the wharf up to 500 metres further upstream. The limit of this area is bounded on the northeast by the railway track berm and bounded on the east by the flats area of the town of Churchill.

The available area within 500 metres of the wharf is about 9 hectares, but could conceivably extend up to 70 hectares if it were possible to include all the tidal flats area 1.5 kilometres south of the wharf. The elevation varies from 0 to 6 metres above LWOST at the rail lines on the east edge of the site.

1.5 Wharf (Figure 1-2)

The original or old wharf was constructed in 1929-1930 after the rail line to Churchill was constructed in 1928. The wharf was originally 518m long and in 1961 was extended at the north and south ends 168m and 157m respectively for handling general and other cargos.

The wharf is constructed of rock ballasted timber cribs and on the breasting face the cribs are 14.9m wide at the base by either 30.5 or 47m in length by 17m high.

The timber cribs are constructed of 300 x 300mm treated B.C. Fir and on the front or berthing face. An additional layer of timber is placed against the timber cribs, providing a double wall. Another layer of timber planking is secured to the face, providing additional wear protection. These planks are annually repaired or replaced because of ice damage. The berthing face is also sloped 12:1 and a timber curb is located on the top edge of the cribwork.

A second series of timber cribs is located on the inside edge of the wharf north of the conveyor causeway. These cribs are somewhat smaller than the face cribwork. They vary from 7.3m to 9.8m in width and are 30.5m long and built to a height of 5.8m.

An 116m section of the wall on the east side of the wharf just north of the "old wharf" consists of a rubble embankment.

At the south end of the winter berths, a 115 metre section of the wharf wall is constructed of steel sheet piles with a concrete cope beam.

The area between the two rows of timber cribs originally constructed was gradually filled with gravel and fill over the next few years after construction.

The wharf has an overall length of 843m with a width of 91m at the north end. There is water access on all four sides of the structure, providing the following berthing arrangements, as previously stated: on the west face are three grain berths and two general or bulk cargo berths; the north face is usually used by the resupply barges for loading bulk fuels; the east face behind the wharf is used for loading the resupply barges as well as being used for the winter berths; the south face is used for berthing smaller tugs and work boats.

The southern 230 metre portion of the wharf is connected to shore and the elevator by an earthen approach or causeway. This approach is used for all access to the wharf and is traversed by rail line, roadways and grain conveyor from the elevator.

The elevator machine shop and power house and the Arctic Grain Company pelletizing plant are also located on the causeway. The roads and rail line run the length of the wharf and off the southeast corner towards the town of Churchill. Other buildings on the wharf are the transit shed, water pumphouse which is at the south end of the wharf, and a small office complex for the various operations and officials of the port.

1.6 Wharf Facilities

The wharf has a surface area of 7.26 hectares, of which there is approximately 4.0 hectares available for open storage, the main area being to the north of the transit shed.

The wharf is traversed by two groups of rail tracks running from the south - one group up the main wharf face under the loading gallery and the other set running by the east side and also into the transit shed, and continuing almost to the north end of the wharf. The rail lines are in poor to fair condition. The apparently unused line along the wharf's west edge is in very poor condition.

The majority of the wharf and approaches are gravel surfaced and there is one loading-unloading ramp for rail cars located outside, north of the transit shed.

The wharf area is supplied with 550 volt power and is well lighted for night work with high level, high pressure sodium lights.

Two waterlines 400mm diameter and 457mm diamater respectively run across the south end of the wharf from the elevator powerhouse to a pumphouse at the south end of the wharf to supply vessels with fresh water.

Fuel and petroleum products for resupply are transferred via a series of pipelines running from the Esso tank farm east of the elevators along the railway berm, then underground to the south end of the wharf, up the east face and across the wharf to an underground header, at about midway across the wharf on the north face. There are two 100mm and one 150mm pipelines serving the dock at this time. It is noted, however, that the facility is not equipped to receive product but could be with minor changes.

Vessels are usually refueled from tanker truck at the southern end of the wharf. Only diesel fuel is available for bunkering; there is no supply of the heavy fuels for ocean-going vessels.

1.7 Transit Shed Covered Storage

A steel framed and clad transit shed is located midway along the wharf. It provides approximately 7,973 square metres of covered storage, of which some 5,574 square metres are divided and leased to the resupply operator. The remaining portion is used by Ports Canada for a warehouse for elevator and gallery equipment and spares. The facility is lighted but unheated or insulated, and is equipped with a new sprinkler system. A rail spur enters the shed from the south and runs the length of the shed along the east wall. Box cars are unloaded directly from the door level floor inside the shed. The resupply operator has installed their own shrink rap machines, repair shop, etc. Access to the wharf is through either end of the shed. The shed is well maintained and in relatively good condition.

1.8 Repair Facilities

A complete machine shop is located on the causeway to the wharf, which is used primarily to service the elevator equipment. All the facilities are available for marine work and repair and have been used quite extensively. In fact, the port aluminum work boat was fabricated here. Some of the available equipment includes: MIG welder; full range of electric arc and oxtactelyne welding and cutting equipment; full range of machining equipment - lathe, milling machine, presses, etc.; a 5mm plate bender, as well as a small quantity of light steel plate in stores.

Of all the vessels that have suffered ice damage over the years the repairs, although only temporary, have always been sufficient to allow the vessel to take on its load of grain and depart.

1.9 Grain Facilities

The grain handling facilities consist of a track shed which handles and receives grain via four sets of tracks entering from the north which serve four car dumpers and two hopper car bins, discharging to four sets of receiving scales and conveyors running to the elevator workhouse. Grain is received at a rate of 1,225 tonnes per hour (45,000 bushels). The main terminal facilities consist of a workhouse and two storage annexes with 100 bins. After weighing by car load lots, the grain is elevated and conveyed to bins serving the cleaners or to storage bins for later cleaning. After the grain is cleaned, it is conveyed to one or more of the twelve bins serving the outgoing weighing hoppers, or is conveyed to storage bins for later shipment. The cleaning capacity is 850 tonnes per hour. From the weighing hoppers the grain is fed to one of the four conveyor belts, which deliver grain to the spouts on the gallery. The dock is served via a four-belt conveyor system running from the elevator across the causeway to the loading gallery on the west face of the wharf. The gallery spans the length of the original 1931 wharf and has 23 loading spouts serving the three main berths. The shipping capacity is 1,633 tonnes per hour (60,000 bushels) from the four conveyors. (1)

1.10 Petroleum Facilities

Esso maintains a terminal which is the only significant shipper of petroleum products over the wharf. The other oil Company presently in town is Shell, which competes with Esso for the local fuel requirements and, on the marine side, fueling tugs and resupply vessels. Esso owns and operates the tank farm which is located immeditely east of the elevator on about 10.5 hectares leased from Ports Canada.

(1) From Canada Grains Annual Report
Grain movements through the Port of Churchill in 1976.

At the present time, all product is received by rail but in the past, prior to 1980, overseas oil was received. Now the use of the Harbour is limited to resupply shipments for the Keewatin Ports and diesel bunkering. The supply lines to the dock are two 100mm lines and one 150mm line running north of the elevator and to an underground header at the north end of the wharf about mid-way across the wharf. Bunkering is done by tank truck directly to the wharf.

The tank farm facilities include four diesel storage tanks with a capacity of 40,000,000 litres; three gasoline tanks with total storage of 4,000,000 litres; one diesel (dyed) storage tank of 2,300,000 litres, and one tank for Turbo B with a capacity of 1,430,000 litres. There were four large 200mm lines running to the wharf face that were used to receive and ship product but these have since been removed. In 1985 about 20,000,000 litres of product will be shipped.

1.11 Port Equipment

Vessel handling and cargo handling equipment at the port includes:

Floating Plant

(a) The tug "W.N. Twolan", built in 1962 in Lauzon, Quebec, 29 metres long and 299 gross tons, twin screw, single rudder, equipped with two 760 HP diesel engines, two fire- fighting monitors, ice reinforced hull for ocean travel and accommodation for 8 crew.

(b) The tug "George Kydd", built in 1960 in Owen Sound, Ontario, 13.1 metres long, steel hull at 21 gross tons, 600 HP diesel engine for harbour use only.

(c) A new 6 metre aluminum boat , with 110 HP outboard motor, used for sounding work.

(d) A twelve-section flexi float assembly barge, total size 9.1 metres x 39.6 metres.

Onshore Equipment:

(a) A 90 tonne crawler crane with 36-metre boom and 9-metre jib boom, complete with attachments and drum laggings for crane, clam and drag work. A 90-tonne hook block is included although taper tip boom is maximum rated at 69.8 tonnes.

(b) One Dominion 550, 31-tonne crawler crane with 24-metre boom, complete with attachments and buckets for crane, clam and drag work.

(c) Two gas powered Plymouth locomotives used for rail switching throughout the area.

(d) One 5-ton truck; 9 1/2-ton trucks.

(e) One Ford 4-ton platform with Pittman hoist.

(f) One potable 20 HP high pressure boiler on wheels.

In addition to this, the resupply operator, NTCL, has its own equipment, which includes:

2	truck tractors
4	highboy trailers
3	950 Cat 8-tonne forklifts
1	966 Cat 9-tonne forklift
1	910 Cat 4-tonne forklift
7	small Hyster forklifts
1	5-ton Hyster forklift

Other equipment from the local municipalities is available and usually required and includes several loaders, 3 D7 dozers, 1 D5, 2 crawler backhoes, boom truck.

2.0 Present Capabilities and Equipment, Present Constraints

There are two berths available at Churchill for non-grain bulk cargos. The berths are known as Dalgleish Berth, at the north end of the wharf, and Wolfe Berth, at the south. In between these two berths is the grain loading gallery serving the remaining three berths.

At the present time only the grain berths are utilized by deep sea cargo vessels. The Wolfe Berth is used to moor smaller vessels, supply tugs and resupply vessels (other than NTCL), and the harbour tugs. It is also used as a fueling berth for the various vessels.

Dalgleish Berth at the north end of the wharf is presently used for mooring visiting vessels, supply vessels, NTCL resupply barges during turnaround, and other vessels, including grain ships awaiting space at the loading berths.

The north end of the wharf is occupied largely by the main resupply operator, Northern Transportation Company Ltd. (NTCL), who primarily use the east and north berthing faces for their operation. NTCL lease over 75% of the wharf area north of the transit shed for storage but generally occupy or use the entire area. In July and early August virtually all of the wharf space north of the transit shed is used for cargo storage, until some of the first shipments to the resupply ports.

The wharf has several sets of rail lines running its length and there is no provision for unloading bulk cargos other than by cranes unloading hopper cars.

The area available for open storage is approximately 2.1 hectares at the north end and 2.0 hectares at the south end of the wharf. The wharf has several sets of rail lines and smaller structures, such as loading ramps, pipelines, sheds, lights, that would have to be relocated to fully utilize the available storage areas, particularly for bulk cargos.

In the past, bulk sulphur was shipped out of the Port. The handling procedure entailed unloading the rail cars by crane to a stockpile north of the elevator on shore, well back from the wharf. The cargo was then reloaded and transferred to the wharf by truck, where it was dumped and loaded on the vessel by crane. This method proved to be unsatisfactory and relatively slow. The procedure required double handling of the cargo and was very time-consuming with the equipment available.

Storage of bulk cargos on the wharf itself, however, will conflict with some of the ongoing operations. Firstly, the resupply operation (NTCL) requires a large amount of space, as previously mentioned, and would have to be relocated if bulk cargos were stored and shipped at the north end of the wharf. There are no adequate alternative berthing or storage facilities available to accommodate the NTCL operation easily or conveniently without major capital works. The south end is not a suitable storage area for the present resupply operation that uses barges. It is too far from the transit shed and loading area.

Secondly, the south end of the wharf is congested with other operations, as previously described, and may not be large enough to accommodate several shipments of bulk cargos. The main rail and road access to the wharf also pass through the south end of the wharf, which would create additional storage problems and decrease the usable storage area.

Thirdly, by occupying either of the berths north or south of the loading gallery, the larger bulk vessels would overhang part of the grain loading berths, particularly for 30,000 tonne vessels or larger. This may interfere somewhat with normal grain vessel berthing, particularly during peak traffic. Optimum grain loading procedure is to have three vessels at the wharf, one topping up on the tide, one vessel loading or awaiting for loading, and the third vessel at berth, preparing for loading. With a fourth vessel taking on other bulk cargos, the third vessel preparing to receive grain would have difficulty berthing, or may have to moor offshore, which would be an inconvenience and may also cause minor delays to shipping with the present port operations and volumes.

3.0 Areas for Expansion or Development

Based on the physical layout of the Harbour facilities, the influence of the River and ice conditions, and the general site hydrography and topography, three potential areas for port expansion have been identified: north of the existing wharf, behind the existing facilities, and a southerly extension of the present grain wharf. These development areas have been classified north, central and south, and are evaluated in the following sections.

3.1 Area North of Wharf (Figure 3-1)

3.1.1 Description

Immediately north of the wharf is a small bay bounded on the north by the steep, rocky outcrop forming the Cape Merry Peninsula; on the east by a gently sloping sandy beach, and on the south by the dredged channel to the winter berth area. This channel around the north end of the existing wharf is 74 metres wide, with a depth of three metres, except where it has been deepened against the wharf to 6 metres.

This area consists mainly of tidal flats rising up a sandy beach towards shore. The area available for reclamation (Figure 3-1) is about 5.2 hectares and would extend from the winter berth channel about 310 metres northward along the Harbour headline towards Cape Merry Peninsula. Additional storage area could be created by cutting into the low rocky backshore area east of the existing rail line. The topography of the site ranges from 0 to 7 metres above LWOST (or Chart Datum).

The foreshore area is presently used as a landing for various small craft, such as tour boats, pleasure craft, etc. In addition, an analysis of a small craft docking facility for the Churchill Community Development Corporation by Anderson Management Services Inc., in February 1984, selected this area as one of two feasible sites for a marina.

3.1.2 Reasons for Site Selection

This area north of the existing wharf has the advantage of ready access to the deep water dredged channel with minimum additional dredging required. A relatively large storage area is available, which could be expanded, as required, to the east of the railway track. It provides a natural extension to the present facility. It is easily accessible by rail and road. It would have to be separated from the main wharf to maintain access to the winter berthing area, however, the slip that would be formed would provide additional berthing space.

The development of this area may cause some concerns as part of the area is thought to be historically significant and belongs to Parks Canada.

3.1.3 Proposals for Development

This additional land and berthing area presents two distinct development opportunities. One being the shipment of additional commodities, bulk materials in particular; the other being the expansion of the resupply operation, combined with bulk material storage and handling.

(i) Additional Commodities

This site offers almost unlimited open storage for bulk materials and a deep sea berth adjacent to the existing channel. Although dredging quantities will be relatively small, the presence of bedrock is suspected, from discussions with previous dredging contractors, which could result in excessively high development costs. Rail access could be provided by an extension of the existing trackage serving the grain elevators and arranged so that unit trains would not interfere with the grain operations. The type of dock structure would be determined from terminal throughput requirements which would establish the need for travelling shiploaders with a marginal type wharf, or fixed shiploaders with a less costly dolphin type wharf.

(ii) Additional Commodities Plus Resupply Expansion

The requirement to maintain the access channel to the winter berth affords the opportunity to construct a new shallow draft berth along the south limits of the development. This berth and a suitable backup area could provide extra storage and loading facilities for the resupply operation. Such a configuration is indicated in Figure No. 3-1.

3.2 Area Central to Wharf (Figure 3-2)

3.2.1 Description

The water area immediately behind the existing wharf facility, which is presently utilized for winter berthing, presents an interesting opportunity for reclamation for bulk storage. The area of about 100 by 600 metres would provide about 4.3 hectares of storage and would only require a short berm at its northern opening to retain the reclamation.

3.2.2 Reasons for Site Selection

Additional open storage area, adjacent to deep water and existing wharves are the prime requirements for handling additional commodities at the Port. Although such a development would totally displace the existing resupply operation and further would require the relocation of the winter berths, the scale and requirements of these operations do not justify occupying prime wharfage and potential storage areas immediately adjacent to deep water. Facilities for handling limited volumes of bulk material can be provided at the central area and resupply and winter berth facilities provided elsewhere, at a much lower cost, than locating bulk handling facilities at either the other north or south alternatives.

3.2.3 Proposal for Development

The development of the central area for bulk handling facilities would have to be limited in scale so as not to interfere with the more important operations of grain handling. Due to the proximity of the grain facilities, operations of material delivery, stockpiling and shiploading would require careful scheduling to avoid interfering with or contaminating the grain movement. In order to accommodate bulk vessels at the wharf without major tidal restrictions, it is preferable to have a berth depth of 12.2 metres (40 feet). However because of the relatively low traffic, in the order of 10 vessels over the season, short delays (12 hrs) should not cause serious problems and berth depth need not be increased.

An alternate to relocating the resupply operation and using the wharf and winter berths for bulk storage is to store the cargos onshore north of the elevator complex and transfer them to the wharf by a high overhead conveyor .This would feed a travelling shiploader on the wharf west face serving the vessels. This travelling shiploader and its associated equipment would occupy approximately the western one-third of the wharf area north of the grain loading gallery.

This would, however, decrease the storage area available to the resupply operator. Significant alterations to the present storage methods and handling systems would be required, particularly during peak periods in July and early August. These could be accomplished within the confines of the present facilities, with improved efficiencies, utilization of storage areas, etc.

3.3 Area South of Wharf (Figures 3-3, 3-4)

3.3.1 Description

Immediately south of the wharf is an area of tidal flats, increasing in width from about 60m at the south end of the wharf to approximately 4km to 6km upstream of the wharf. This area roughly corresponds to the area bounded by the 0m sounding which is in line with the present Harbour headline on the west and the rail line, or the high water line on the east. These tidal flats extend upstream an unlimited distance but, for practical reasons, the area is limited to about 6km.

This area is relatively flat and, unlike the development site to the north, would require extensive dredging to allow access for deep draft vessel traffic.

The open area within the previously mentioned parameters could be up to 70 hectares but if a first stage of development is proposed and only the area within 500m of the wharf is selected approximately 7 hectares of filled area would be available.

3.3.2 Reasons for Site Selection

The area south of the wharf has the advantage of having unlimited land areas available for reclamation. It would be possible for it to be connected directly with the existing facility and would not interfere at all with any of the ongoing port operations. It is readily accessible from town and to the rail line, and forms a natural extension to the port facilities to the south.

The disadvantages are that any development here would require extensive dredging to extend the turning basin and berth, and environmentally and aesthetically its location adjacent to the town may cause some problems if undesirable cargo, such as sulphur, is stored.

3.3.3 Proposals for Development

The unlimited open area and lack of development south of the existing wharf, provide the opportunity to develop a bulk handling facility of almost unlimited proporations. However, extending the berthing face southward also requires a comparable extension of the turning area, necssitating the dredging of substantial quantities.

An alternative development is indicated on Figure No. 2-4. This configuration, with its berthing face at right angles to the existing wharf, serviced by a reclaimed area of about 7 hectares, forms the root of an ice barrier which, if necessary, could be extended along the west side of the turning basin. A similar configuration was tested in the National Research Council (NRC) hydraulic ice model study and the results indicated that the arrangement should be quite effective in improving the early ice conditions at the grain berths during season extension. A further advantage to this alternative is the substantial reduction in dredging, although reclamation quantities are proportionately higher.

With respect to bulk handling operations, both alternatives provide adequate facilities; good rail and road access, ample storage area of about 7 hectares and substantial expansion capabilities.

4.0 Construction Methods

The type of wharf structure required for bulk facilities is primarily dependent on the terminal throughput and the type of loading equipment required. A smaller facility (in terms of tonnage handled), using a stationary shiploader requires only breasting and mooring dolphins. A minimum of three dolphins is required, with additional dolphins for larger vessels, to facilitate moving the vessel during the loading cycle. In practice for larger vessels, five to seven breasting points are required, with two external mooring points to facilitate vessel movings.

Conversely, large capacity terminals using travelling shiploaders require a continuous dock structure for at least seventy percent of the length of the vessel. Accordingly, marginal wharves cost from two to five times that of dolphin configurations are required.

For Arctic or near Arctic waters, all structures must have a vertical or near vertical closed-type perimeter. Open structures, such as pile supported dolphins, are subject to vertical ice forces and would be displaced after a few seasons. Thus, dolphin-type structures are usually constructed of steel sheet pile cells, although concrete or timber cribs can also be employed. Similarly, marginal wharves are usually constructed as a steel sheet pile bulkhead, or alternatively from timber or concrete cribs. In some applications, circular steel sheet pile cells are used to form a continuous wall.

At Churchill, with a 12.2 metre depth and 5 metre tide, plus normal freeboard, the wall loadings may exceed the capacity of a steel sheet pile bulkhead.

5.0 Evaluation of Alternatives

Table 1 following, presents an evaluation of the various atlernative development opportunities in terms of facilities, operations, maintenance, capital costs and other constraints.

5.1 Facilities

The evaluation of facilities and capacities is made difficult by not knowing the definitive requirements which will be needed in response to the many development opportunities identified. These unknowns include the volume of commodities to be handled, as well as the number and types of commodities.

Large commodity movements of a dry bulk type could be moved through the Port of Churchill utilizing the North or either of the South alternatives. All can easily accommodate shipments in the order of 1.0 million tons per year. Further, additional land area could be made available at all three sites to accommodate larger movements, at a cost.

The North development could be extended eastward, at a considerable sitework cost, to meet the storage needs of a variety of commodities, and also the storage capacity requirements for servicing a second loading berth.

Similarly, the South inline development has unlimited expansion potential in terms of storage area and additional berths. Expansion costs would be the least of all the North or South alternatives.

The South offshore alternative also has unlimited expansion potential but at a cost which would be substantially more than the South inline alternative, and probably more in line with the cost of the North alternative expansion.

All three alternatives would have adequate depth at the wharf of 12.2 metres and a minimum of 290 metres of berth length.

TABLE NO. 1

EVALUATION OF ALTERNATIVES

MARINE FACILITIES

ALTERNATIVE	FACILITIES				OPERATIONS				MAINTEN-ANCE	CAPITAL COST	CONSTRAINTS
	Capacity T/Yr	Area Ha.	Berth Length	Berth Depth	Rail Access	Road Access	Navigation Access	Ice Conditions			
North	1.0m+	8.5+	290m	12.2m	good	good	good	fair	nominal	$29.6m	. Potential land use problem
Central											
. Wharf Storage (NTCL Relocation)	0.3m	4.3	200m	10.7m	limited	limited	limited	fair	nominal	$17.1m	. Interferes with grain operation
. Onshore Storage	0.3m	5.0+	200m	10.7m	good	good	limited	fair	nominal	$ 3.5m	. Contamination . Relocation
South											
. Inline	1.0m+	6.6+	300m	12.2m	good	good	good	fair	nominal	$20.6m	. Environmental
. Offshore	1.0m+	7.1+	360m	12.2m	good	good	good	better	nominal	$35.0m	

Smaller bulk movements, up to 300,000 tonnes per year, would be handled through the Central alternative. There may be some restrictions on the size of vessel that can use the berth because of the limited berth length of 200 m.

The scheme to store bulk cargos directly on the wharf and in the winter berth area is nearly as costly as developing an entirely new facility north or south of the wharf because of the relocation of the resupply operation. The alternate central development option, using a shiploader with an overhead conveyor to shore, is by far the cheapest of all the alternatives in that it does not require any new marine facilities to be constructed, and that it does not require relocation of the resupply operation. Furthermore, if scheduling and quantities to be shipped are such that tidal restrictions on loading are not a problem, then additional dredging to deepen the berth may not be required. This would also be applicable at the other development sites but because of high capital cost their construction would be contingent on much greater cargo throughput, berth depths less than 12.2 metres, and hence tidal restrictions (delays up to 12 hours per vessel) would pose major scheduling and loading difficulties. 1,000,000 tonnes of cargo would require at least 30 vessels per season at the berth.

The expansion potential for the central development alternatives is limited. There is no additional berth space for expansion of the marine facilities on the existing wharf. The first alternative for central development , storing bulk cargos on the wharf and in the winter berth area, is restricted in expansion of storage areas because of the elevator and rail lines to the south and east. However, the second alternative, utilizing an inshore storage area, would have large quantities of land available for storage expansion.

5.2 Operation

Operations are evaluated on the basis of rail, road and vessel access and egress, as well as ice conditions which are likely to be encountered during the fall season.

In these categories, all three large-scale alternatives exhibit equal capacity regarding site access and egress. Only the Central alternative is limited by the adjacent grain handling facilities.

Although ice conditions within the Harbour would be similar for the North, Central and South (inline) alternatives, based on the model test results of the NRC, the South offshore alternative should experience less severe problems with slush and other floating ice conditions. Similarly, the South offshore alternative should yield an additional benefit to fall operations at the grain berths. Due to its position in the River, upstream of the grain berths, ebb currents and loose ice conditions should be improved at the other berths.

5.3 Maintenance

There should be no difference experienced to the maintenance required for any of the marine structures in the alternatives. In total, maintenance dredging within the Harbour should not significantly change from that which has been experienced since diversion of the Churchill River. The only exception might be that the South offshore alternative might result in less dredging at its own berth, probably accompanied by a comparable increase in dredging at the grain berths.

5.4 Capital Costs

Capital costs for each site alternative have been developed in 1985 dollars and include:

- dredging
- land reclamation
- marine structures
- site drainage
- transit shed and loading ramp (for relocation of resupply facility)

Table 2 presents a breakdown of these estimated costs for each of the alternatives. Total estimated costs also include costs equivalent to approximately fourty percent of the construcion costs to allow for:

- contingencies
- administration
- engineering

Total estimated costs for each alternative are indicated in Table No. 2. Of the alternatives, two basic options are apparent. For large-scale operations, development south of the existing wharf would be the most cost-effective solution. However, for cargos in the order of 200,000 to 300,000 metric tons per year, the development of the central alternative at the north end of the main wharf is by far the least costly.

5.5 Constraints

Of the five alternatives investigated, both the North and Central ones are subject to constraints not evident with either South alternative. The North alternative appears to only have a constraint with regard to potential land use, particularly if storage expansion is anticipated. The Central alternatives, which would require the relocation or reorganization of the resupply operation, have the potential of interfering with, and possibly contaminating the grain operations.

5.6 Summary

(i) The Central alternative with onshore bulk storage and a high overhead conveyor to the wharf face provides the least costly facility for the movement of limited volumes of bulk commodities, the potential problems which could be caused to the grain movement and the operating constraints which it would impose on both bulk commodities, grain movements and resupply operations are outweighed by the relatively low capital costs for marine and storage facilities when compared to the other choices.

(ii) Although capacity of the other three alternatives possibly exceeds the future requirements at Churchill, they each present an acceptable site for bulk commodities. Of these alternatives, the Northern one is probably least desirable because of the potential land use problems, and of the Southern alternatives the inline alternative is far less costly and is the preferred location for bulk handling.

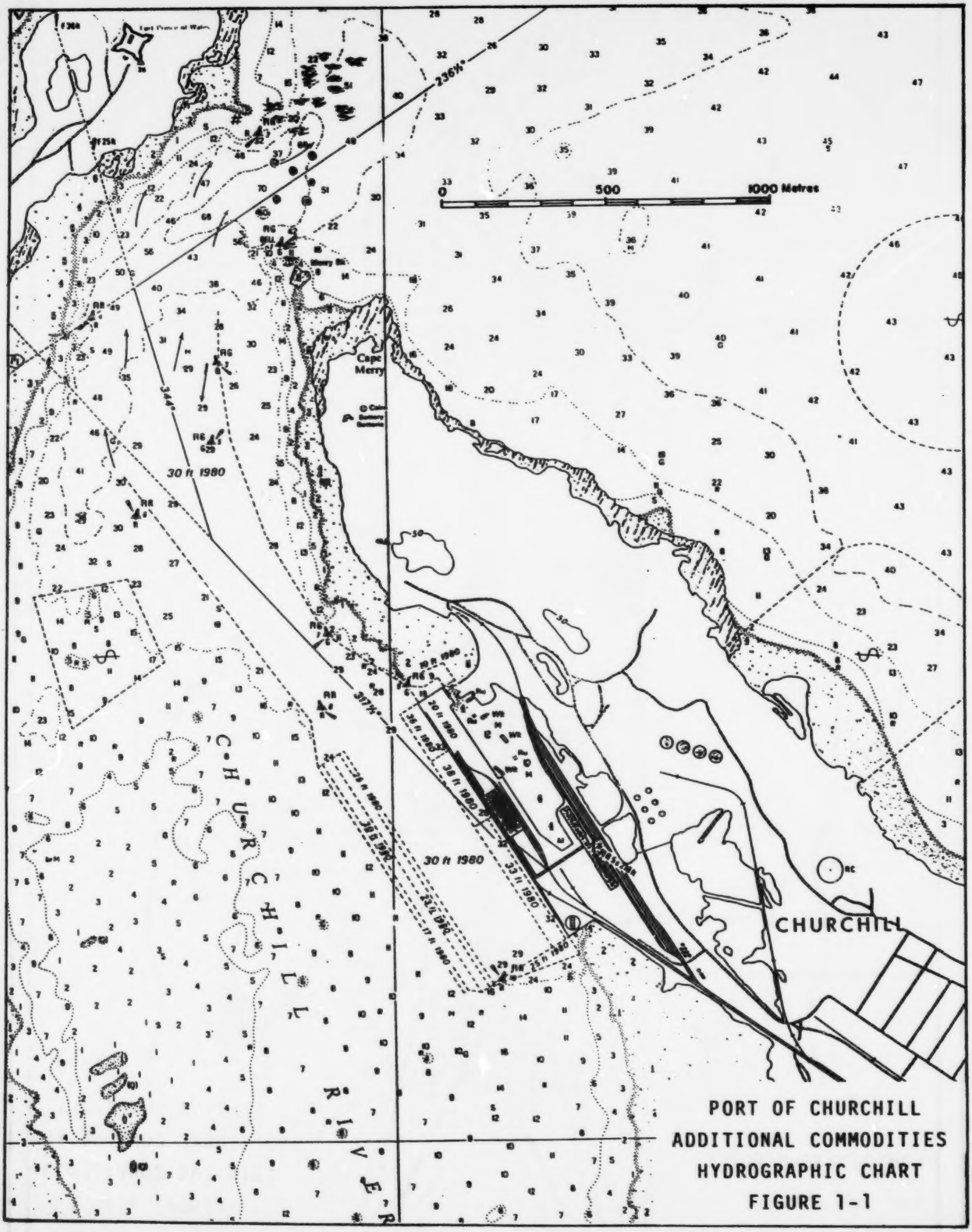
(iii) The South inline alternative does not restrict future Port development and both the winter berth and the resupply operations could be relocated to that area and easily integrated into the southerly port expansion.

TABLE 2

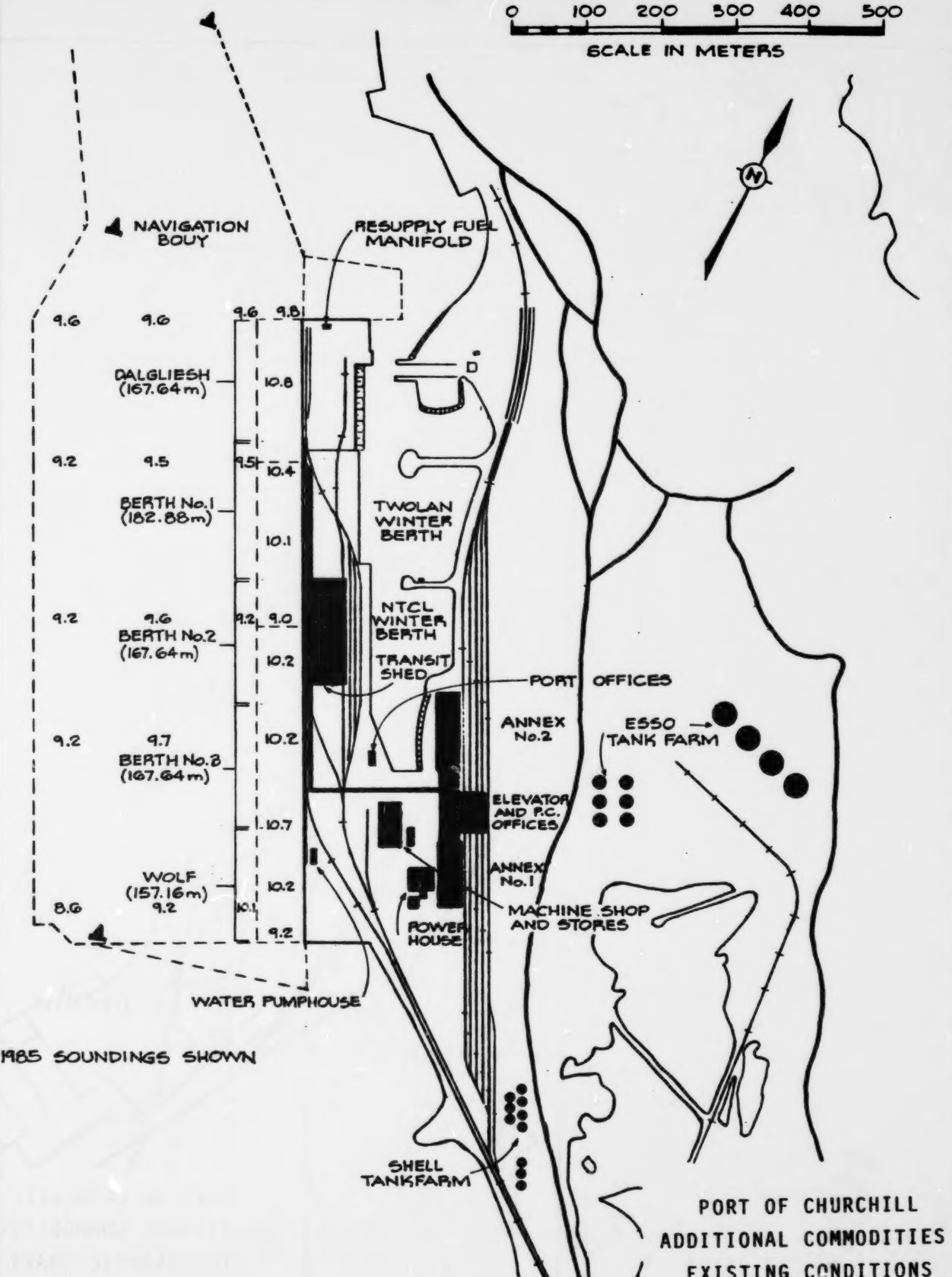
DEVELOPMENT COSTS

($ Millions)

Development Alternative	Mobilization	Marine Structures	Land Reclamation & Fill	Dredging	Buildings	Administration, Engineering & Contingencies	Total
North	1.0	9.8	1.2	9.2	-	8.4	29.6
South							
. Inline	1.0	7.7	1.2	4.8	-	5.9	20.6
. Offshore	1.0	14.5	10.0	.5	-	10.0	35.0
Central							
. Wharf Storage (NTCL Relocation)	.8	4.0	4.6	.6	2.2	4.9	17.1
. Onshore Storage	.1	-	2.5	-	-	1.0	3.5

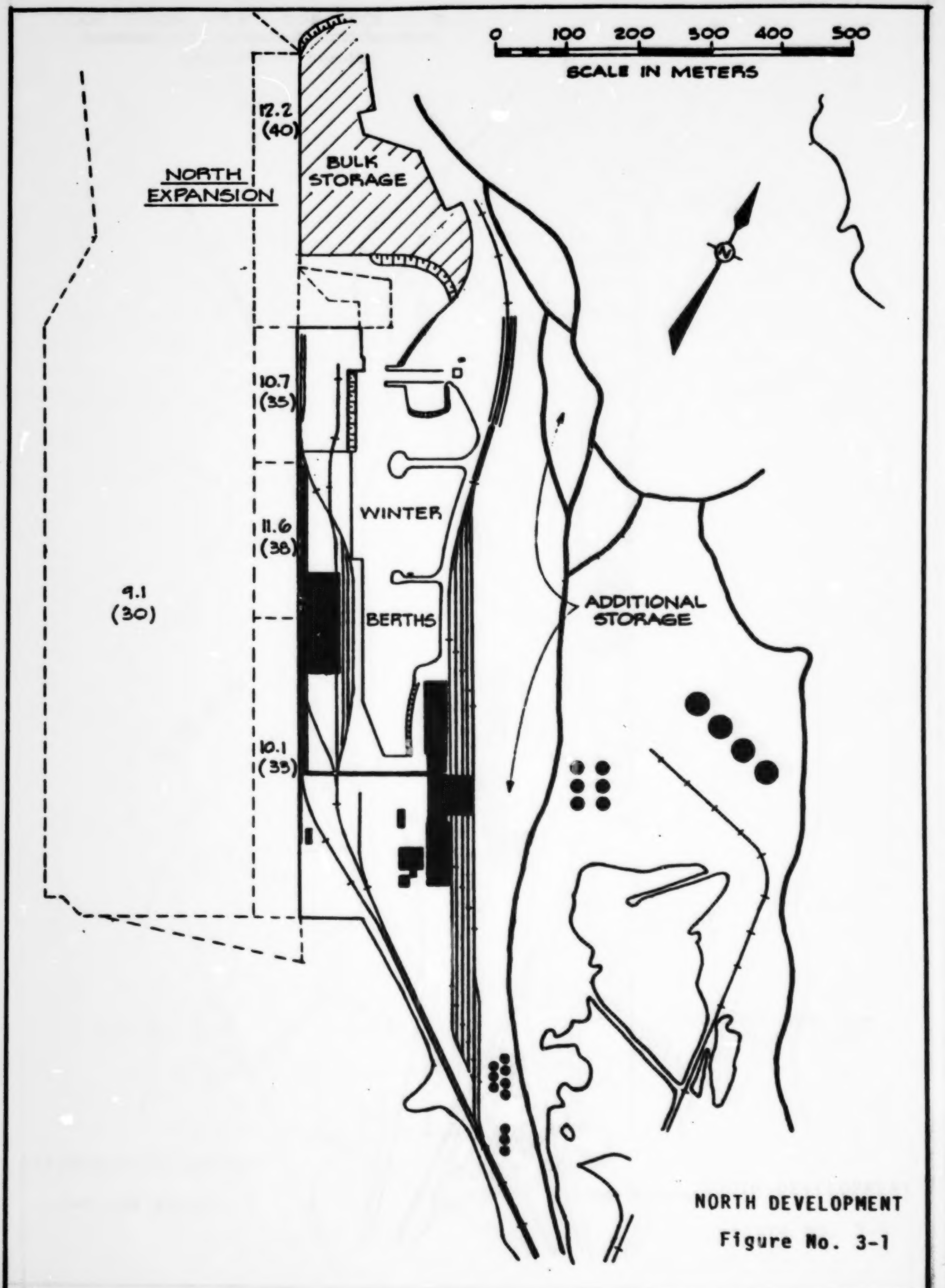

Fort Prince of Wales
236½°
0
500
1000 Metres
344°
30 ft 1980
Cape Merry
317½°
20 ft 1980
38 ft 1980
33 ft 1980
CHURCHILL RIVER
CHURCHILL

PORT OF CHURCHILL
ADDITIONAL COMMODITIES
HYDROGRAPHIC CHART
FIGURE 1-1


0
100
200
300
400
500
SCALE IN METERS
N
NAVIGATION BOUY
RESUPPLY FUEL MANIFOLD
9.6
9.6
9.6
9.8
DALGLIESH (167.64m)
10.8
9.2
9.5
9.5
10.4
BERTH No.1 (182.88m)
TWOLAN WINTER BERTH
10.1
9.2
9.6
9.2
9.0
NTCL WINTER BERTH
BERTH No.2 (167.64m)
10.2
TRANSIT SHED
PORT OFFICES
ANNEX No.2
ESSO TANK FARM
9.2
9.7
10.2
BERTH No.3 (167.64m)
ELEVATOR AND P.C. OFFICES
10.7
ANNEX No.1
WOLF (157.16m)
10.2
8.6
9.2
10.1
9.2
MACHINE SHOP AND STORES
POWER HOUSE
WATER PUMPHOUSE
SHELL TANKFARM

1985 SOUNDINGS SHOWN

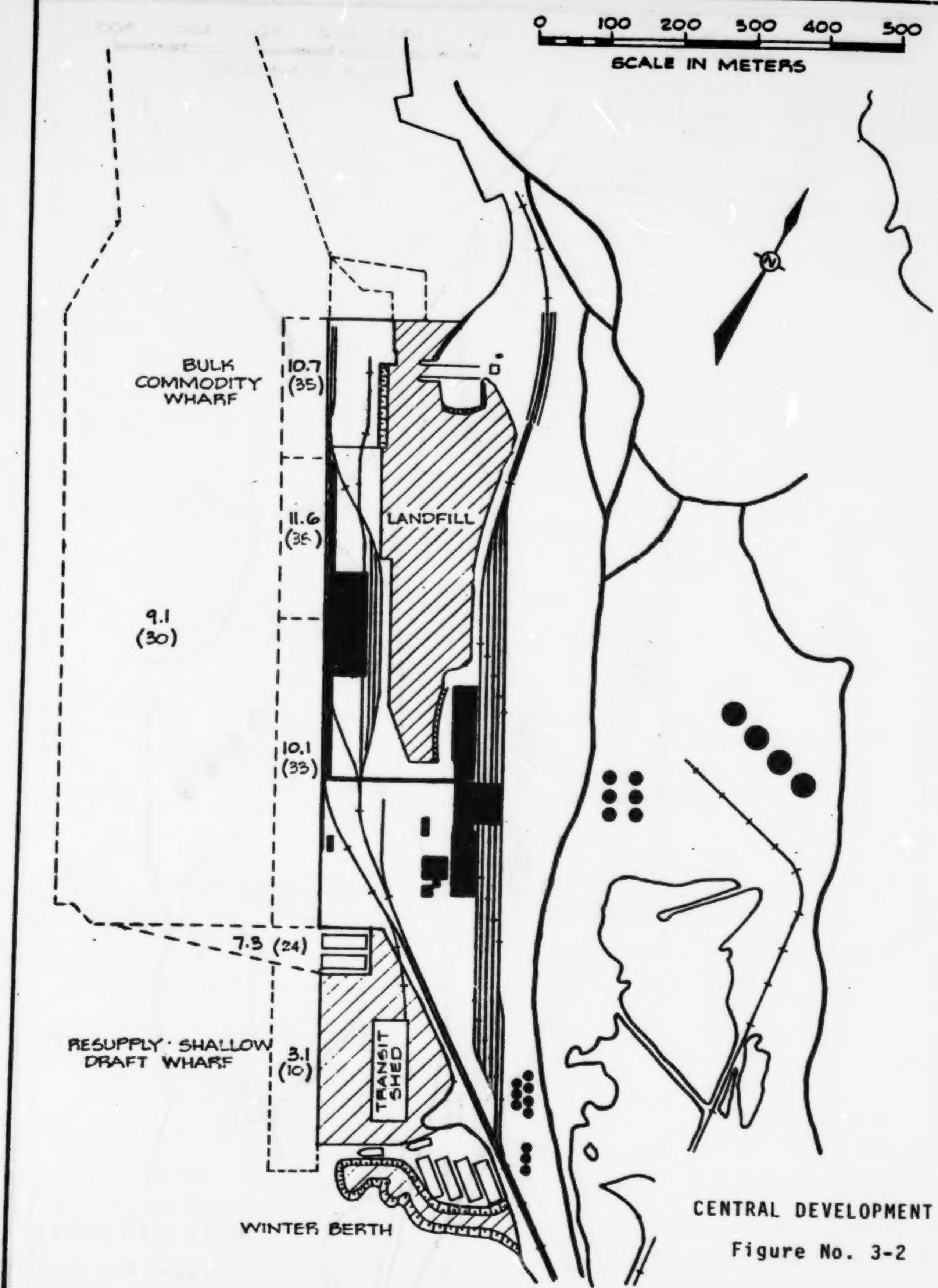
PORT OF CHURCHILL
ADDITIONAL COMMODITIES
EXISTING CONDITIONS
FIGURE 1-2



0 100 200 300 400 500
SCALE IN METERS
12.2
(40)
BULK STORAGE
NORTH EXPANSION
10.7
(35)
WINTER
BERTHS
11.6
(38)
9.1
(30)
10.1
(33)
ADDITIONAL STORAGE
N

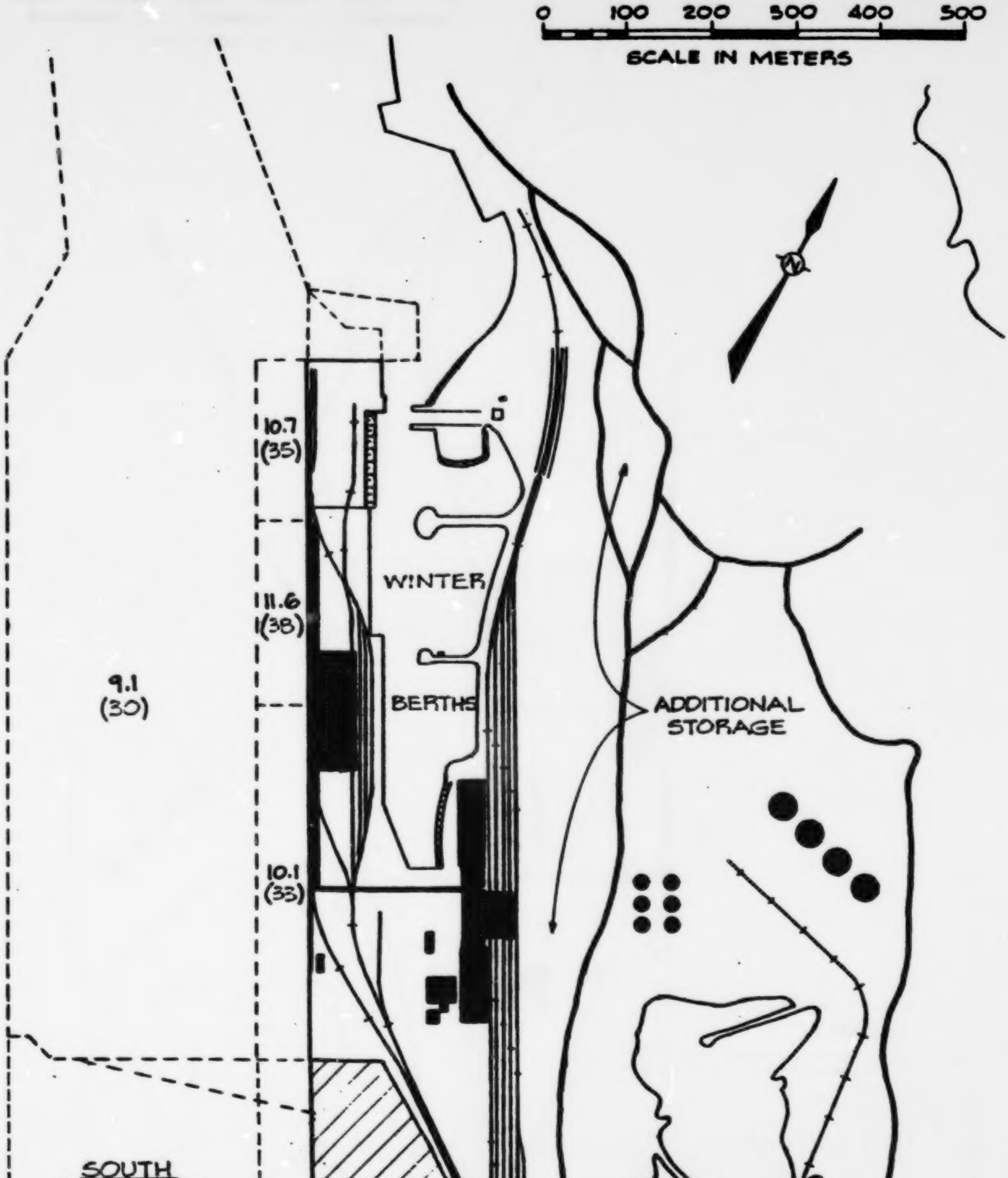
NORTH DEVELOPMENT

Figure No. 3-1


0
100
200
300
400
500
SCALE IN METERS
N
BULK COMMODITY WHARF
10.7 (35)
11.6 (38)
LANDFILL
9.1 (30)
10.1 (33)
7.3 (24)
RESUPPLY · SHALLOW DRAFT WHARF
3.1 (10)
TRANSIT SHED
WINTER BERTH

CENTRAL DEVELOPMENT

Figure No. 3-2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100
200
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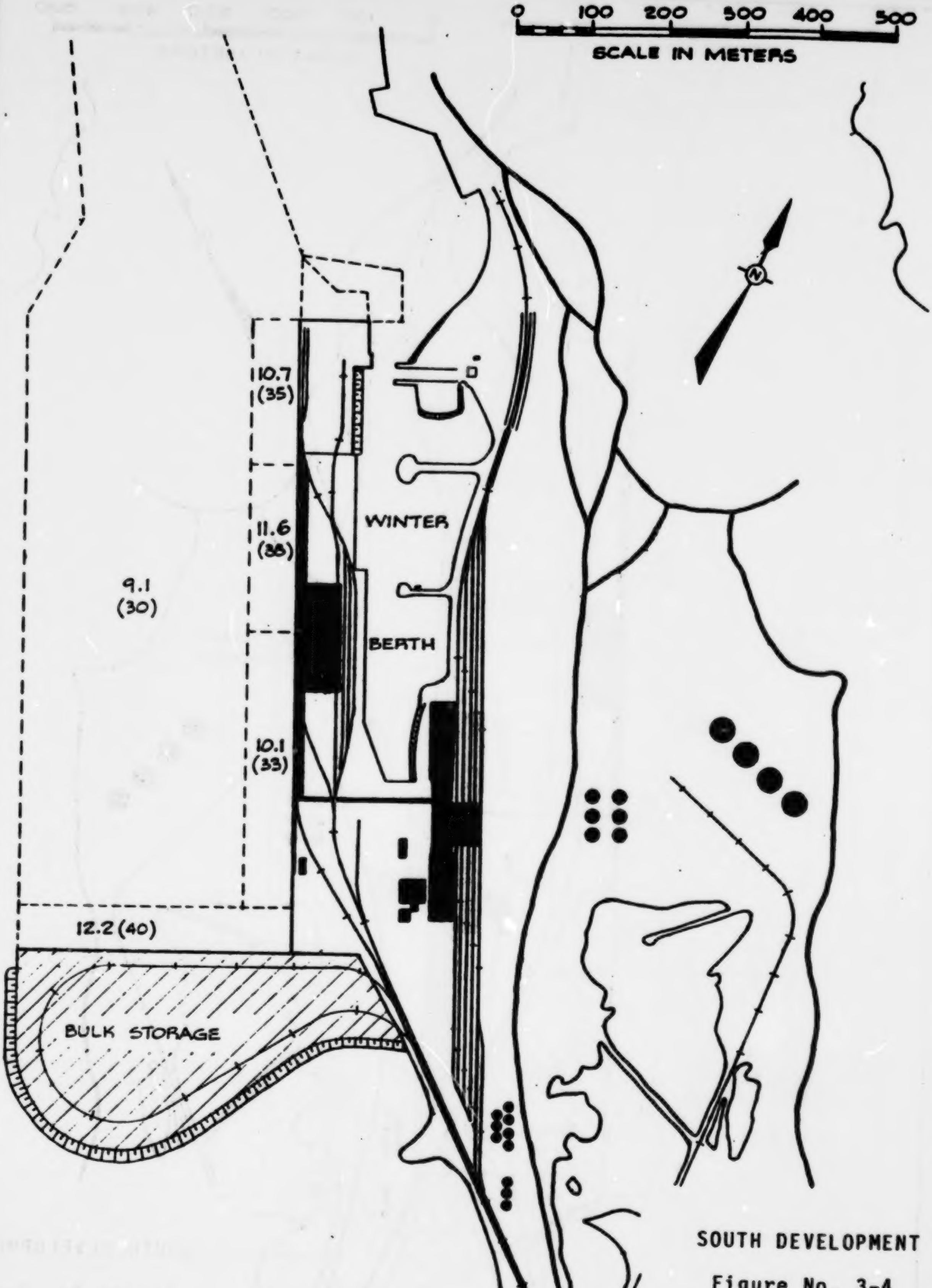
400
500
SCALE IN METERS
10.7
(35)
11.6
(38)
10.1
(33)
12.2
(40)
9.1
(30)
WINTER
BERTHS
ADDITIONAL
STORAGE
SOUTH
EXPANSION
9.1 (30)
BULK
STORAGE

SOUTH DEVELOPMENT

Figure No. 3-3


0
100
200
300
400
500
SCALE IN METERS
N
10.7
(35)
11.6
(38)
9.1
(30)
10.1
(33)
WINTER
BERTH
12.2 (40)
BULK STORAGE

SOUTH DEVELOPMENT

Figure No. 3-4

APPENDIX E

INVESTIGATIONS OF HANDLING OF NON-GRAIN COMMODITIES THROUGH THE PORT OF CHURCHILL

CARR & DONALD ASSOCIATES

MARCH, 1986

INVESTIGATION OF HANDLING OF NON-GRAIN COMMODITIES THROUGH THE PORT OF CHURCHILL

Prepared for

IBI GROUP

By

CARR & DONALD & ASSOCIATES

March 1986

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PORT OF CHURCHILL

STUDY B - ADDITIONAL COMMODITIES STUDY
MATERIAL HANDLING ASPECTS RELATING TO MOVEMENT OF COMMODITIES OTHER THAN GRAIN, THROUGH THE PORT OF CHURCHILL

1. INTRODUCTION

The IBI Group were selected by agencies of the government of Canada and the province of Manitoba to carry out a group of studies to explore the potential for further development of the Port of Churchill. One of the study areas involves an analysis of the potential for and the economic feasibility of attracting additional commodities other than grain through the port.

Carr and Donald and Associates were engaged by the IBI Group to form part of their study team, to provide input with respect to commodity material handling requirements, along with capital and operating cost implications as relating to the handling through the port of those commodities which from investigation, are indicated to have potential for movement through Churchill in the future.

2. SYNOPSIS

Eight (8) material handling schemes relating to the handling of inbound and/or outbound non-grain commodities which have been identified as having potential for movement through the Port of Churchill, were investigated.

Investigations as applying to the individual material handling schemes were directed towards obtaining:

- Assesment of throughput capacity achievable.
- Order of magnitude of capital and operating costs.
- Identification of relative advantages, disadvantages, and limitations and restrictions which would apply.

A brief description along with summary of related costs, operating features and limitations as applying to the individual schemes is given in section 6 of this report.

None of the schemes investigated would provide the facility to allow for handling of the combined potential maximum inbound and outbound commodity throughput (as initially projected for this study), over a single dock berth.

3. NON-GRAIN COMMODITIES DESIGNATED AS HAVING POTENTIAL FOR MOVEMENT THROUGH THE PORT OF CHURCHILL

The following non-grain commodities have potential for future movement through the Port of Churchill:

	Commodity Type	Potential Maximum * Seasonal Throughput Tonnage (MT)
Inbound (import) commodities	Phosphate rock, urea	400,000
	Alumina	400,000
	Base Metal Concentrates	100,000
	Petroleum Products (received in tanker)	24,000
Outbound (export) commodities	Sulfur	400,000
	Forest products (pulpwood, finished paper)	100,000
	TOTAL POTENTIAL MAXIMUM SEASONAL TONNAGE THROUGHPUT OF NON-GRAIN COMMDODITIES	1,424,000

The seasonal throughput potentials for the individual commodities as listed in the proceeding tabulation, may never develop. Consequently, seasonal throughput from the maximum combined as listed, to a minimum of 200,000 MT of inbound or outbound bulk commodity has been taken as the

* Potential seasonal throughput indicated are projections assessed at initial stage of study.

potential throughput range upon which consideration of material handling requirements, related capital and operating costs, and vessel berth occupancy requirements have been based.

All of the inbound solid bulk commodities involved with this study, with the exception of the base metal ore concentrates are relatively free-flowing at normal commercially-accepted moisture content levels, and could be readily unloaded from self-unloader type vessels equipped with tunnel reclaim/boom conveyor discharge. As the base metal ore concentrates tend to be sticky and non-free-flowing, they would require clam-equipped cranes to unload vessels.

With the exception of the petroleum and forest products, all of the commodities listed can be handled by conveyor.

None of the inbound or outbound bulk commodities, with the exception of sulfur, can be stockpiled un-protected. While covered storage is not required for the ore concentrates, it is preferable, particularly in a region where freezing conditions combined with rain or snow can be expected. Sulfur on the other hand, is normally stockpiled in the open.

4. EXISTING DOCK - POTENTIAL FOR ACCOMMODATION OF VESSELS INVOLVED WITH IMPORT/EXPORT OF NON-GRAIN COMMODITIES

The existing dock is 843 metres long. A grain loading gallery extends along the dock over a length of 448 metres, with distances from the gallery ends to the north and south ends of the dock in the order of 192 and 203 metres respectively.

The dock is adequate to accommodate four (4) 30,000 DWT vessels. The length of coverage along the dock provided by the grain shipping gallery is more than adequate to load two (2) 30,000 DWT vessels simultaneously.

The transit shed and the petroleum product manifold are located within the dock length paralled by the grain shipping gallery.

With existing dredged depths, loaded draft restrictions apply to vessels of 30,000 DWT and larger at lower tide levels.

The existing dock has been considered as four (4) berths, comprised of a north berth, a south berth, and two grain-loading berths.

4.1 GRAIN LOADING BERTHS

As the two (2) grain berths are paralled by the grain loading gallery, and by the transit shed over part of their lengths, they are unsuitable for handling non-grain commodities. In view of the small tonnage of inbound petroleum products, petroleum could be handled over these berths, without applying any significant restriction to loading grain vessels.

4.2 SOUTH BERTH

The south berth is presently used primarily for tying up port service tugs, supply vessels for oil exploration, and other development north of Churchill. The dock apron area back of the berth is traversed by rail tracks serving the transit shed and dock areas to the north.

Assuming that a shallow draft berth were provided elsewhere to accommodate the port tugs, supply vessels, etc., the south berth could become available for handling of non-grain commodities. With limitations on placement of on-ground storage, and/or installation of fixed material handling equipment, handling inbound or outbound bulk product at this berth appears impractical. Handling of forest product over the berth, which would not involve fixed material handling installations, and/or large on-ground storage area requirement, could be accommodated.

4.3 NORTH BERTH

Presently, this berth's primary use is for tieing up vessels waiting to move to one of the grain loading berths.

Northern Transportation Company operations presently take place over the dock area associated with this berth, occupying the dock north-end and the back (east) side of the dock in the winter berth area. Large areas of the dock apron are occupied with materials awaiting loading onto the Northern Transportation marine equipment.

If facility for the Northern Transportation Company were to be provided elsewhere, or if it was agreed, that the eastern half of the dock apron area paralleling the north berth would be adequate for their purposes, this berth could be utilized to accommodate vessels involved with the transport of inbound or outbound non-grain bulk commodities.

5. SELECTION OF MATERIAL HANDLING SCHEMES INVESTIGATED

5.1 GENERAL

Basic criteria for this study are outlined below:

5.1.1 Material handling alternatives should be investigated for each of the following:

- Alternatives for handling inbound solid bulk commodities of similar nature.
- Alternatives for exporting solid bulk commodity (sulfur).
- Alternatives for exporting forest products.

5.1.2 With the initially projected throughputs, high capacity dock-based shiploading and unloading equipment is not justified.

5.1.3 Prime consideration should be given to schemes involving utilization of present dock berth and support areas.

5.2 RAIL TRACK FACILITY

5.2.1 Existing rail track at the port is considered dedicated to handling grain through the port. Consequently, addition of operating and storage trackage for handling of non-grain commodities through the port should be allowed for.

6. MATERIAL HANDLING SCHEMES

6.1 GENERAL

Eight (8) separate material handling schemes applying to handling of non-grain commodities through the port of Churchill were investigated.

Four (4) of the schemes (schemes I to IV) involve the handling of inbound solid bulk commodities utilizing the existing north dock berth, and a portion of the adjoining dock apron area.

Scheme V is an alternative which provides for handling of outbound sulfur, with vessel loading at the existing north berth.

Scheme VI is an alternative which assumes that a new separated dock facility located to the north of the existing dock would be provided, which would be utilized in the handling of both inbound and outbound solid bulk products.

Scheme VII is an alternative which provides for the handling of outbound forest products over the dock at the existing south berth.

Scheme VIII is an alternative which provides for handling inbound phosphate rock and outbound sulfur and potash over the existing north dock berth.

Of the schemes investigated involving handling of inbound bulk commodities, only Schemes IV and VI, provide for inbound throughput capacity approaching or meeting the potential maximum inbound tonnage as initially projected for study purposes. Of the schemes involving handling of outbound commodities, only Schemes V and VII, initial study projected maximum throughput could be accommodated. Investigations carried out, indicate that initial study projected combined maximum inbound and outbound throughput tonnage could not be handled over any one single berth dock, without high capacity ship loading and unloading equipment being available.

A brief outline of the handling facility contemplated, throughput capacity and handling rates, order or magnitude capital and operating cost estimates, and of advantages, disadvantages and possible restrictions for each scheme is given in the following section.

For each scheme, capital and operating costs are tabulated at various throughput levels up to the maximum which could be handled in a 13 week season.

Capital costs have been estimated for the permanent material handling equipment and facilities. Capital costs are equally applicable to an extended season, as well as to the present 13 week season.

Operating costs for an extended season would increase due to longer term rental of equipment. Other components of the operating costs such as labour, fuel, maintenance, and power would vary in direct proportion to throughput, regardless of length of season.

6.1 SCHEME I

No Storage - Direct Ship to Rail Car Load-out - Vessel at Existing North Berth

200,000 to 300,000 MT of inbound product - unloaded from vessel by crane facility to dock receiving conveyor (equipped with movable receiving hoppers) - to elevating unit to track surge hopper to car loading - over track scale. All located on existing north wharf section.

Reference Layout Plan	Drawing No. P1
Maximum Seasonal Throughouput Capacity (13 week marine season)	300,000 MT
Average Material Handling Rate over a 10 hour shift *	200 - 225 MTPH
Vessel Berth Availability for Handling Outbound Product	None at maximum inbound throughput level
Rail Car Handling Service	
- Yard to load out station and return	By CN
- At car loading track	With car haul facilities

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* On longer shift basis, average material handling rate would remain in 200-225 MTPH range.

SCHEME I

6.1.1 CAPITAL COST - ESTIMATE

1. Dock Conveyor with 3 wheel mounted receiving hoppers	$560,000.
2. Elevating Unit to Car Load-Out surge bin (inclined bucket elevator or chain conveyor)	$130,000.
3. Car Load-out facility (Single Track) (Steel tower structure & fnd'n, surge bin, loading chutes, track scale, and Car Haul Facility)	$750,000.
4. Railway Trackage (including yard track for two train lengths plus by-pass, working track)	$3,500,000.
5. Electrical services - Power, controls, lighting, etc.	$160,000.
TOTAL ESTIMATED CAPITAL COST	$5,100,000.

SCHEME I

6.1.2 OPERATING COST - ESTIMATE

Seasonal Inbound throughput	200,000 MT	300,000 MT
1. Operating Labour	$292,000.	$430,000.
2. Crab equipped unloading cranes (3) (100 MTPH Cap/Crane) (rental - 4 months rail freight fuel, maintenance)	$600,000.	$625,000.
3. Power Consumption	$12,000.	$18,000.
TOTALS	$904,000.	$1,081,000.
OPERATING COST /MT	$4.52	$3.60

SCHEME I

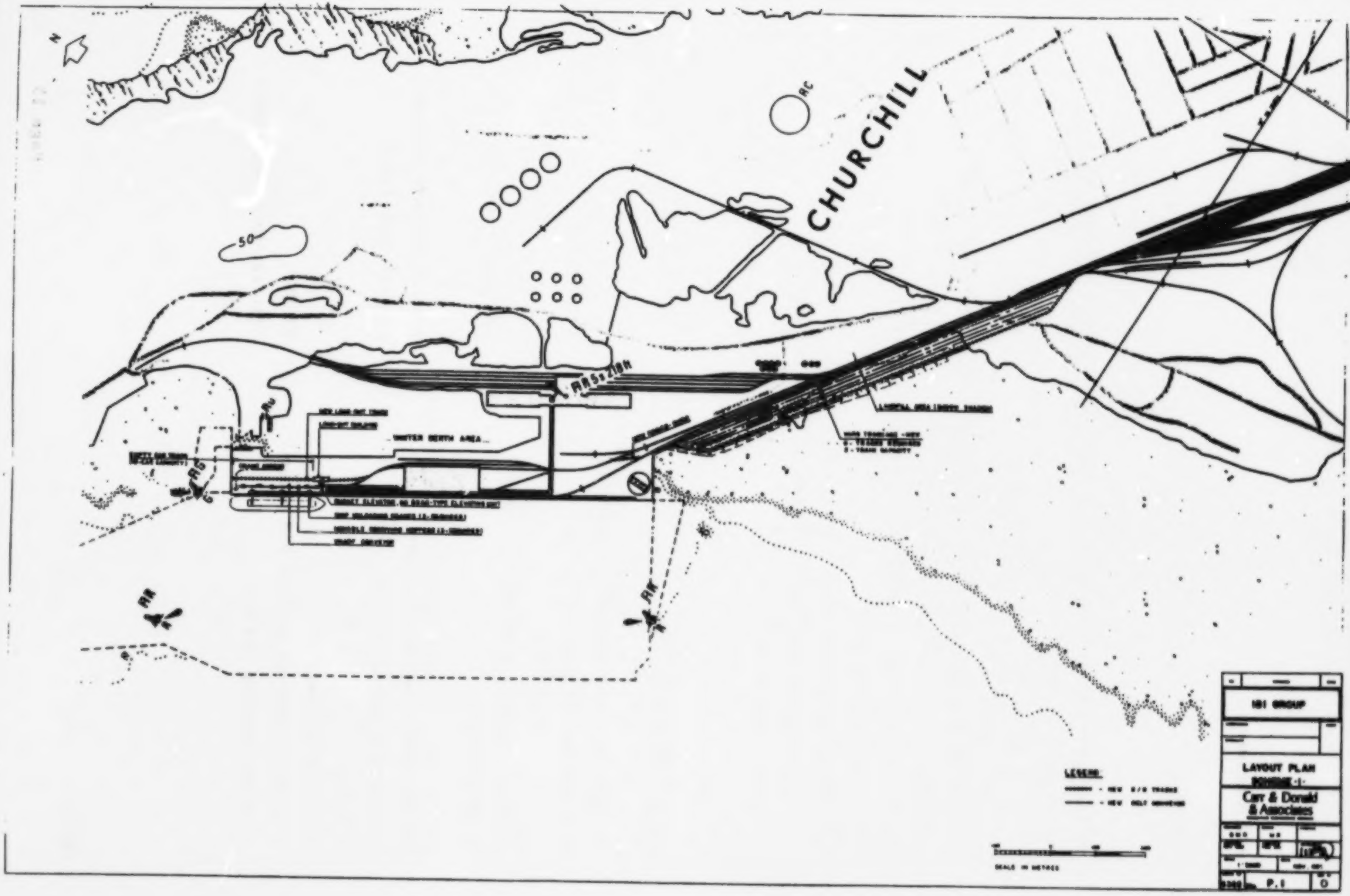
6.1.3 ADVANTAGES, DISADVANTAGES, AND POSSIBLE RESTRICTIONS APPLYING TO HANDLING SCHEME I

ADVANTAGES RELATIVE TO OTHER SCHEMES INVOLVING HANDLING OF INBOUND SOLID BULK COMMODITIES

- Utilizes existing dock facility
- Lowest capital cost requirement of any of schemes considered.

DISADVANTAGES AND POSSIBLE RESCTRICTIONS

- Highest operating cost any of schemes investigated involving handling of inbound solid bulk commodity, at similar throughput.
  Low seasonal throughouput capacity, and material handling rates.
- Frequent movement of rail car strings over trackage at dock areas resulting in potential interference with operation of dock transit shed.
- Handling equipment and track facility at north dock area occupies areas used by Northern Transportation Company, which may necessitate new facilities for Northern Transportation Company at another location.
- Vessel turnaround time relatively long (10 days approx.) due unloading rate restriction.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6.2 SCHEME II

No Storage - Direct Ship to Single Rail Car Load-out - Vessel at Existing North Berth

200,000 to 400,000 MT. of inbound product - unloaded from vessel by grab-equipped cranes and conveyed to car load out via:

- Receiving dock conveyor provided with travelling receiving hoppers.
- Transfer elevating conveyor to single shore-based car loading station, with over-track surge, hopper and track scale.

Reference Layout Plan	Drawing No. P2
Maximum seasonal throughput capacity (13 week marine season)	400,000 MT
Average material handling rate over a 10 hour shift	260 MTPH
Vessel berth availability for handling outbound product	None at maximum inbound throughouput level
Car handling service -	
- Yard to load-out station and return	BY CN
- At car loading track	With car haul facilities

SCHEME II

6.2.1 CAPITAL COST - ESTIMATE

1. Dock Conveyor with 3 wheel - Mounted Receiving Hoppers	$560,000.
2. Transfer elevating conveyor to over-track surge bin, and track scale, provided at single loading track - (conveyor, supporting gallery structure and foundations)	$1,530,000.
3. Car load-out station (incl. steel structure, surge bin, loading chutes, track scale, and foundations, car haul system)	$800,000.
4. Railway trackage (including operating tracks at car load out station (10 car capacity) plus yard trackage for 2 train capacity plus by-pass track)	$5,420,000.
5. Electrical services - power, controls, lighting, etc.	$350,000.
TOTAL ESTIMATED CAPITAL COST	$8,660,000.

6.2.2 SCHEME II - OPERATING COST ESTIMATES

Seasonal Inbound - vessel to cars	200,000 MT	300,000 MT	400,000 MT
1. Operating Labour (4 unloading from vessels 4 car loading - 1 conveyor man	$208,000	$311,000	$416,000
2. Grab-Equipped unloading cranes (3) (rental-4 mos., rail freight, fuel & maint.)	600,000	633,000	665,000
3. Electrical Power Consumption	16,000	24,000	32,000
TOTALS	$824,000	$968,000	$1,113,000
OPERATING COST/MT	$4.12	$3.23	$2.78

SCHEME II

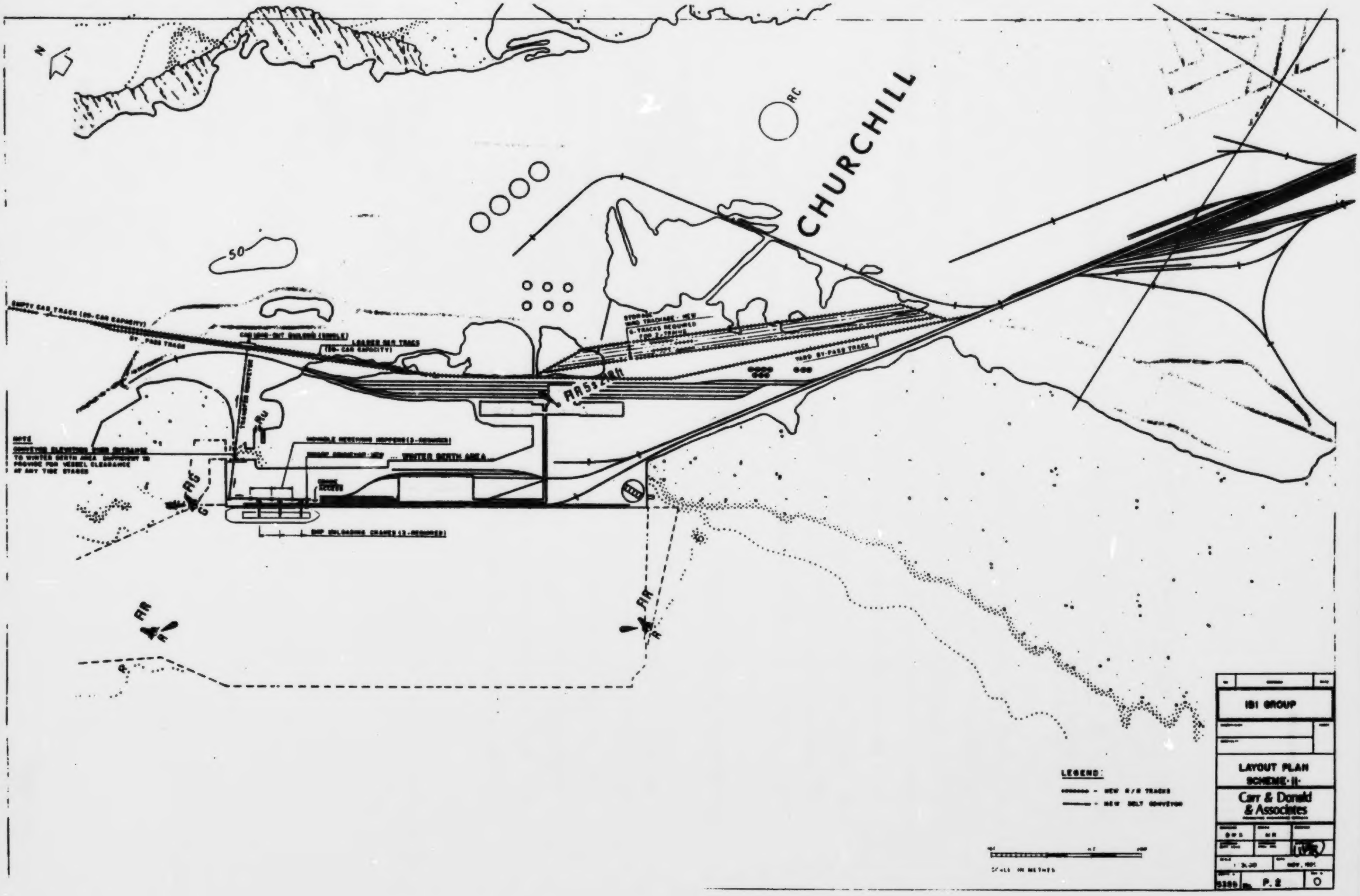
6.2.3 ADVANTAGES, DISADVANTAGES, AND POSSIBLE RESTRICTIONS

ADVANTAGES RELATIVE TO OTHER SCHEMES INVOLVING HANDLING OF INBOUND SOLID BULK COMMODITIES

- Utilizes existing dock facility.
- Operating cost per MT lower than for Scheme I, at equal throughput
- Areas occupied by handling facility equipment at north dock area much less than involved with Scheme I, and probably would not limit Northern Transportation Company operations to any great degree.
- No rail car movement required over existing dock areas.
- Throughput capacity higher than Scheme I.
- Yard service by CN less than Scheme 1.

DISADVANTAGES AND POSSIBLE RESTRICTIONS

- Capital cost greater than Scheme I.
- Throughput is only of inbound bulk.
- Even though potential for interference with Northern Transportation operations less than for Scheme I, provision of alternate facilities for Northern Transportation Company may be required.
- Vessel turn-around time relatively long.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EMPTY CAR TRACK (20-CAR CAPACITY)
BY-PASS TRACK
CAR LOAD-OUT BUILDING (SINGLE)
LOADED CAR TRACK
(20-CAR CAPACITY)
STORAGE - NEW
YARD TRACKAGE - NEW
6-TRACKS REQUIRED
FOR 2-TRAINS
YARD BY-PASS TRACK
MOBILE RECEIVING HOPPERS (2-REQUIRED)
WINTER BERTH AREA
SHIP UNLOADING CRANES (2-REQUIRED)
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CONVEYOR ELEVATION FROM ENTRANCE
TO WINTER BERTH AREA SUFFICIENT TO
PROVIDE FOR VESSEL CLEARANCE
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- NEW BELT CONVEYOR
SCALE IN METRES
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Carr & Donald
& Associates
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6.3 SCHEME III

No Storage - Direct Ship to Twin Rail Car Load-Out - Vessel at Existing North Berth

200,000 to 600,000 MT of inbound product brought in by boom - equipped self-unloading vessels - unload to dock conveyor with one movable receiving hopper, and conveyed to twin shore-based car loading tracks, each with over-track surge hopper and track scale - (1000 MTPH receiving-transfer conveying system)

Reference Layout Plan	DRAWING No. P3
Maximum throughput (13 week marine season)	600,000 MT
Average Material Handling rate over a 10 hour shift	520 MTPH
Vessel Berth availability for handling outbound product	None at maximum inbound throughput level
Car Handling Service	
- Yard to load out station and return	By CN
- At car loading track	with car haul facility

SCHEME III

6.3.1 CAPITAL COST - ESTIMATE

1. Dock Receiving Conveyor with single (movable) receiving hopper	$600,000.
2. Transfer - Elevating Conveyor to over track surge bin, and track scale provided @ each of two tracks	$1,610,000.
3. Car Load-Out station over 2 tracks (incl. steel structures, twin surge bins, loading chutes, track scales - twin car haul system, and foundations)	$2,250,000.
4. Railway tracks (including operating tracks at twin car load-out stations plus yards tracks for 2 train capacity & by-pass working track)	$5,580,000.
5. Electrical services - powers, controls, lighting, etc.	$320,000.
ESTIMATED CAPITAL COST-TOTAL	$10,360,000.

6.3.2 SCHEME III - OPERATING COST ESTIMATES

Annual throughput	200,000 MT	400,000 MT	600,000 MT
1. Operating Labour (2 conveyor patrol 8 car loading)	$117,000	$234,000	$351,000
2. Power Consumption Costs	10,000	20,000	30,000
TOTALS	$127,000	$254,000	$381,000
OPERATING COST/MT	$0.64	$0.64	$0.64

SCHEME III

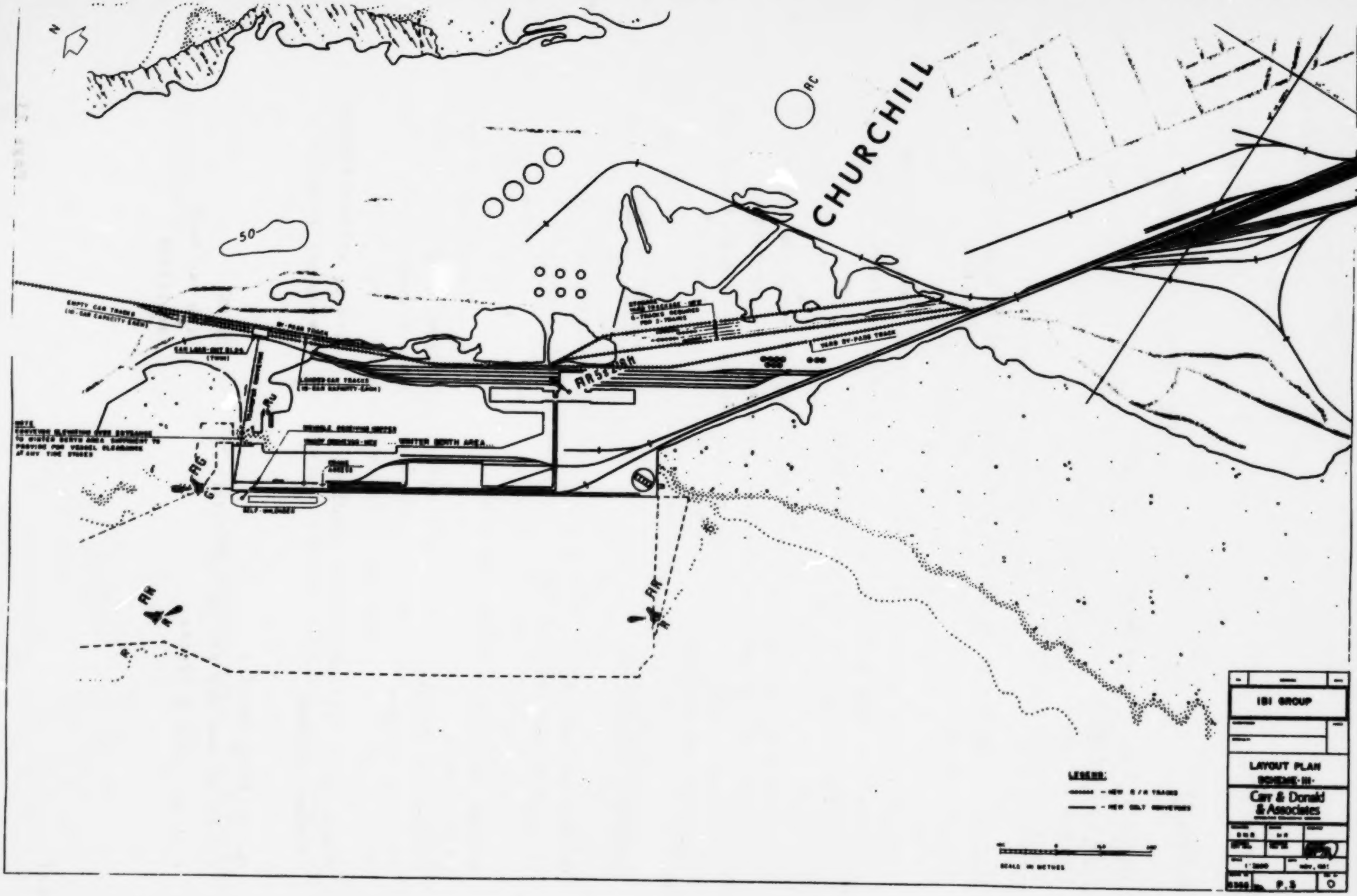
6.3.3 ADVANTAGES, DISADVANTAGES, AND POSSIBLE RESTRICTIONS

ADVANTAGES RELATIVE TO OTHER SCHEMES INVOLVING HANDLING OF INBOUND SOLID BULK COMMODITIES

- Utilizes existing dock facility.
- Operating cost per MT lower than for other schemes for inbound product.
- Areas occupied at north dock similar to those with Scheme II. Interference with Northern Transportation operations at north dock is minimal.
- No rail car movememt required over existing dock areas.
- Throughput capacity significantly greater than with Schemes I and II.

DISADVANTAGES AND POSSIBLE RESTRICTIONS

- Capital cost greater than Schemes I and II.
- Throughput capacity less than projected maximum.
- CN yard service required more frequently than with Schemes I and II.
- Degree of occupancy of north dock area as involved with this scheme might be unacceptable to Northern Transportion Company, requiring provision of alternate facility for their operations.
- Vessel turnaround time relatively long.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WINTER BERTH AREA
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FOR 3-TRAINS
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— NEW BELT CONVEYORS
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6.4 SCHEME IV

30,000 MT Land - based Warehouse Storage
Ship to Storage -
Storage to twin rail Car Loadout Stations
Vessel at Existing North Berth

500,000 to 800,000 MT of inbound product brought in by boom-equipped self-unloading vessels:

- Unload to dock conveyor equipped with one movable receiving hopper transfer to land based storage with two flight transfer/elevating conveyor system at a rate of 2,000 MTPH.
- Reclaim from storage with front-end-loaders onto receiving hopper equipped reclaim conveyor, and transfer/elevate to car loading stations at each of two loading tracks, for car loading at a combined rate of 1200 MT/hour.

Reference Layout Plan	DRAWING No. P4
Maximum throughput (13 week marine season)	800,000 MT
Average material handling rate over 10 hour shift	
- Vessel to storage	1800 MTPH
- Storage to cars	625 MTPH
Vessel Berth availability for handling outbound product	None at maximum inbound throughput level
Car Handling Service	
- Yard to load-out station and return	By CN
- At car loading tracks	With car haul facilities

SCHEME IV

6.4.1 CAPITAL COST - ESTIMATE

1. Receiving - Vessel to Storage	
.1 Conveyor (Dock Receiving to Storage)	$2,250,000.
.2 Support Structures and Foundations associated with Elevated Sections of Conveyors involved with transfer facility from dock to storage	$1,200,000.
2. Storage Building (30,000 MT)	$3,000,000.
3. Shipping - From Storage to Rail Load-Out Station	
.1 Conveyors	$520,000.
.2 Support structures and foundations associated with conveyor runs outside storage bldg.	$530,000.
4. Rail Load-Out Stations (Steel structures and foundations, surge bins, track scales, loading chutes, car haul systems etc.)	$2,250,000.
5. Railway Trackage (including operating trackage serving rail load-out stations plus yard trackage to accommodate one train capacity and a by-pass/working track	$3,900,000.
6. Electrical Services - Power, controls, lighting, etc.	600,000.
CAPITAL COST ESTIMATE-TOTAL	$14,250,000.

6.4.2 SCHEME IV - OPERATING COST ESTIMATES

Annual throughput	500,000 MT	700,000 MT	900,000 MT
1. Operating Labour (4 receiving to storage) (12 storage to cars)	$318,000	$445,000	$572,000
2. Storage Reclaim (F.E.L.-3) (Rental - 4 months rail freight, fuel, maintenance)	391,000	421,000	451,000
3. Power Consumption	31,000	43,000	55,000
TOTALS	$740,000	$909,000	$1,078,000
OPERATING COST/MT	$1.48	$1.30	$1.20

SCHEME IV

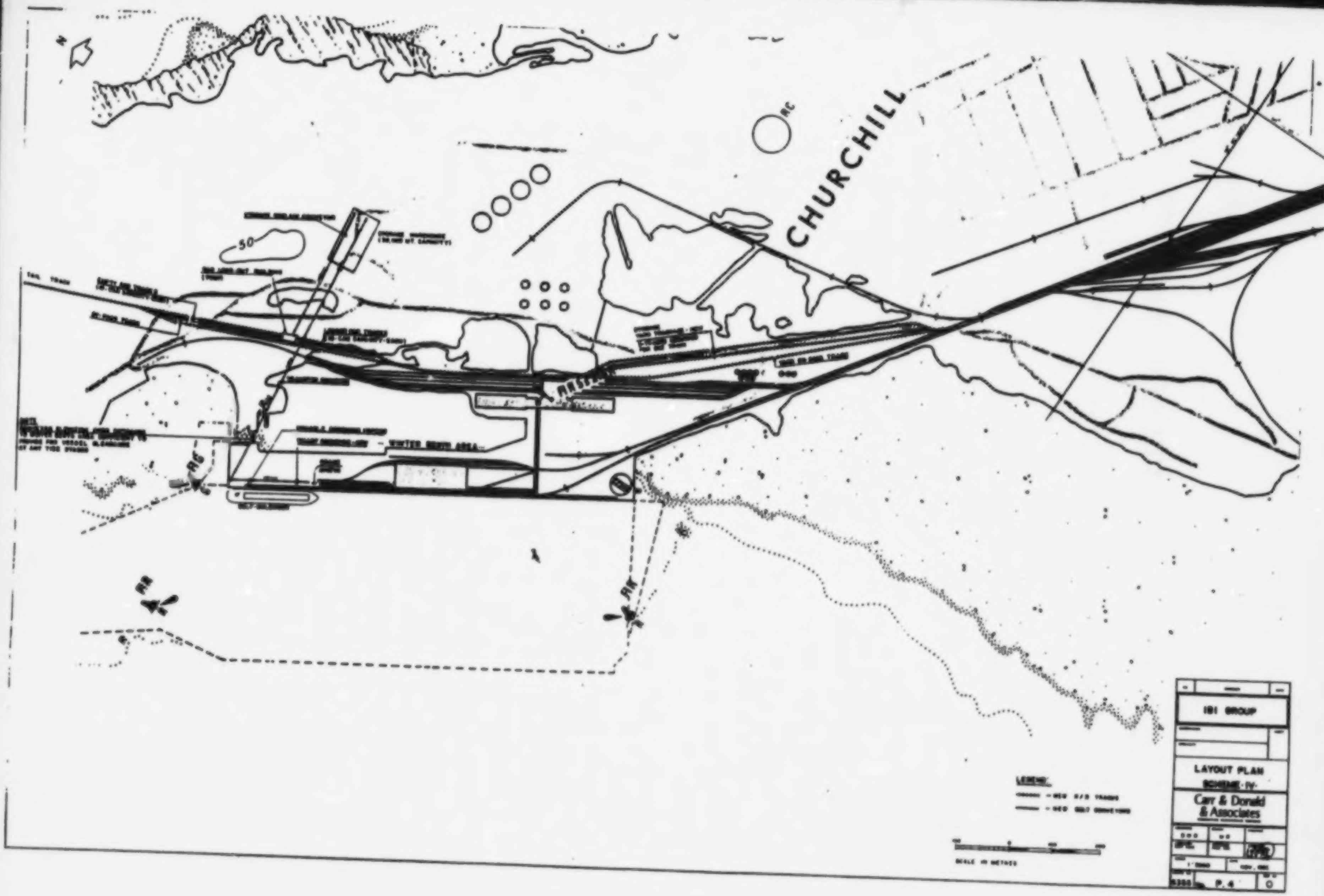
6.4.3 ADVANTAGES, DISADVANTAGES, AND POSSIBLE RESTRICTIONS

ADVANTAGES RELATIVE TO OTHER SCHEMES INVOLVING HANDLING OF INBOUND SOLID BULK COMMODITIES

- Utilizes existing dock facility.
- Operating cost per MT substantially lower than applying to Schemes I and II at equivalent throughput.
- Areas occupied at north dock similar to that involved with Scheme III: Minimal interference with Northern Transportation operations at north dock.
- No rail car movement over existing north dock areas required.
- Study projected throughput could be accommodated.
- Vessel turnaround time less than for Scheme III, and substantially less than Schemes I and II.

DISADVANTAGES AND POSSIBLE RESTRICTIONS

- Capital cost requirement greater than applying to any of the other schemes relating to handling of inbound material.
- C.N. yard service required more frequently as compared to Schemes I and II.
- Degree of occupancy at north dock area may be unacceptable to Northern Transportation Company requiring provision of alternate facility for their operations.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SCHEME - IV -
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6.5 SCHEME V

Outbound Sulfur - Loaded into vessels at Existing North Berth Using Clam-Equipped Cranes

200,000 to 400,000 MT of sulfur brought to Churchill in flat bottom open gondola cars.

- Unload to stockpile at area south and east of existing C.N. rail yards. Car unloading using bridge-supported over-track backhoe. Stockpile build-up utilizing clam-equipped cranes and front-end-loaders.

- Transport in trucks to open-stockpile at existing north dock.

- Load into vessels utilizing clam equipped cranes, with F.E.L. assistance at stock pile.

Reference Layout Plan	DRAWING No. P5
Maximum Throughput	600,000 MT
(13 week marine season shiploading)	
(21 week season for material inbound to Churchill)	
Average Material Handling Rate over 10 hour shift	
- Rail car to primary stockpile	- 150 to 175 MTPH
- Primary stockpile to dock stockpile	- 225 to 475 MTPH for throughput from 200,000 to 400,000 MT
- Dock stockpile to vessel	400 MTPH
Vessel berth availability for handling inbound products	4 weeks approx. @ 400,000 MT sulfur outbound
Car Handling Service	
Storage track to car unloading and return to storage track	With port operated switching locomotive

6.5.1 SCHEME V - CAPITAL COST ESTIMATE

1. Stockpile area preparation at main stockpile area at south-east of main C.N. yard trackage	$400,000.
2. Yard and unloading rail trackage for handling sulfur trains	$2,350,000.
3. Truck haul road between main stockpile area and south end of existing docks	$250,000.
4. Support over-track bridge for car unloading backhoe	$150,000.
5. Yard switch engine	$800,000
ESTIMATED CAPITAL COST-TOTAL	$3,950,000.

6.5.2 SCHEME V - OPERATING COST ESTIMATES

Annual Throughput	200,000 MT	300,000 MT	400,000 MT
1. Operating Labour (car unloading, primary stockpiling, transport and dock stockpiling shiploading)	$475,000	$708,000	$949,000
2. Equipment costs (rental, rail freight, fuel & maintenance)	1,304,000	1,486,000	1,672,000
TOTALS	$1,779,000	2,194,000	$2,621,000
OPERATING COST/MT	$8.90	$7.31	$6.55

SCHEME V

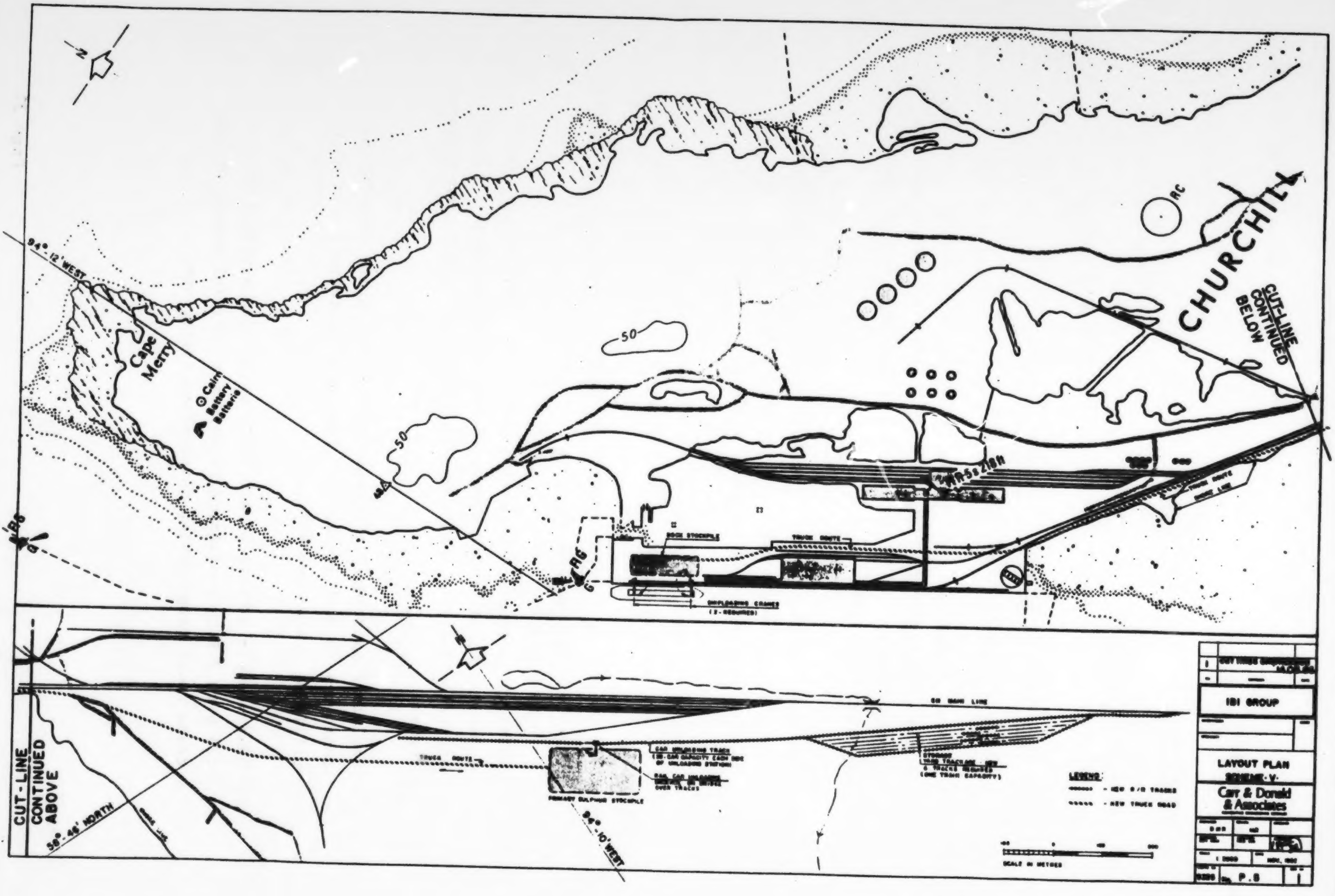
6.5.3 ADVANTAGES, DISADVANTAGES AND POSSIBLE RESTRICTIONS

ADVANTAGES

- Relatively low initial capital cost.
- Scheme assumes primary stockpile build-up prior to start of shipping season; transport demands on CN spread out over longer season.
- Utilizes existing dock facility.

DISADVANTAGES AND POSSIBLE RESTRICTIONS

- Operating costs per MT are high due to number of re-handling operations involved.
- Extensive trucking operations over existing dock areas.
- Dock stockpile would occupy major areas of north dock, and would interfere with Northern Transportation Company operations, requiring that alternate facilities be provided for NTC.
- Vessel turnaround time relatively long.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TRUCK ROUTE
UNLOADING CRANES
(2-REQUIRED)
CN MAIN LINE
CAR UNLOADING TRACK
(10-CAR CAPACITY EACH SIDE
OF UNLOADING STATION)
RAIL CAR UNLOADING
OVER TRACKS
PRIMARY SULPHUR STOCKPILE
STORAGE
YARD TRACKAGE - NEW
6 TRACKS REQUIRED
(ONE TRAIN CAPACITY)
LEGEND:
- NEW R/R TRACKS
- NEW TRUCK ROAD
SCALE IN METRES
IBI GROUP
LAYOUT PLAN
SCHEME-V-
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6.6 SCHEME VI

Inbound and Outbound Product Handled over New Separated Dock Located to North of Existing Dock Berths

1. Up to 900,000 MT of inbound product brought to Churchill in Boom-Equipped Self-Unloading Vessels

   - Unload to dock conveyor equipped with one (1) movable receiving hopper. Transfer to land-based storage warehouse (30,000 MT capacity) with two-flight transfer/elevating conveyor system, at rate of 2,000 MTPH.

   - Reclaim from storage with front-end loaders onto receiving hopper-equipped conveyor for transfer/elevation to single car loading station at loop track, at rate of 1,200 MTPH.

   - Indexing of cars through loading station with C.N. road locomotives (unit train operation).

2. Up to 400,000 MT of outbound product (sulfur) brought to Churchill in flat-bottom open gondola cars

   - Unload to stockpile at area to east of new loop track. Car unloading using bridge-supported over-track backhoe. Primary stockpile build-up utilizing front-end loaders and clam-equipped cranes.

   - Reclaim from primary stockpile with F.E.L.'s and transfer by conveyors to dock stockpile. Stockpile distribution at dock utilizing cranes and F.E.L.'s.

   - Load vessels at rate of 400 MTPH, using clam equipped cranes (2) with F.E.L. assistance to maintain material supply within crane reach range during shiploading operations.

SCHEME VI

Reference Layout Plan	DRAWING No. P6

Maximum Throughput

(13 week marine shipping season)

Inbound product (no outbound throughput)	950,000 MT
Inbound Product (at 400,000 MT throughput of outbound product)	250,000 MT

Average Material Handling Rate over 10 hour shift

Inbound Product	- vessel to storage	1800 MTPH
	- storage to cars	1000 to 1200 MTPH
Outbound Product	- Rail car to primary stockpile	150 to 175 MTPH
	- Primary stockpile to dock stockpile	200 MTPH
	- Dock stockpile to vessel	400 MTPH

Car Handling Service

Inbound Product	By CN Unit train operation over loop track with road locomotives
Outbound Product Storage track to car unloading and return to storage track	With port operated switching locomotives

6.6.1 SCHEME VI - CAPITAL COST ESTIMATES

A. INBOUND PRODUCT - UNLOADING FROM VESSEL TO STORAGE TO CAR LOAD OUT

1. Handling-vessel to storage Conveyors, support structures, and fnd'ns.	$2,510,000.
2. Storage warehouse	$3,000,000.
3. Conveyor from storage to car load-out station	$610,000.
4. Car load-out (load out bldg, foundations, loading chutes, surge hopper, track scale, etc.)	$870,000.
5. Rail trackage (loop track and connection track to main C.N. yard)	$3,230,000.
6. Electrical services (power supply and distribution, controls, lighting, etc.)	$570,000.
TOTAL ESTIMATED CAPITAL COST FOR FACILITIES TO HANDLE INBOUND PRODUCT	**$10,790,000.**

6.6.2 SCHEME VI - CAPITAL COST ESTIMATES

B. OUTBOUND PRODUCT (SULFUR) - UNLOADING FROM RAIL CAR, TO PRIMARY STORAGE TO DOCK STOCKPILE TO VESSEL LOADING

1. Car unloading to primary stockpile (stockpile area preparation, and support bridge for car unloading equipment)	$550,000.
2. Primary stockpile to vessel loading (conveyors and supporting structure and fndn's)	$2,420,000.
3. Yard and car unloading trackage (off main loop track)	$2,350,000.
4. Switch engine for rail car movement	$800,000.
5. Electrical services (power supply and distribution, controls, lighting, etc.)	$300,000.
TOTAL ESTIMATED CAPITAL COST FOR FACILITIES TO HANDLE OUTBOUND PRODUCT	$6,420,000.

.6.3 SCHEME VI - OPERATING COST ESTIMATES

A. INBOUND PRODUCT - VESSEL TO STORAGE TO CAR LOAD-OUT

Annual throughput	600,000 MT	700,000 MT	800,000. MT	900,000. MT
1. Operating Labour	$156,000.	$182,000.	$209,000.	$232,000.
2. Equipment costs (rental, rail freight, fuel & maintenance)	$368,000.	$376,000.	$384,000.	$392,000.
3. Power Consumption	$24,000.	$28,000.	$32,000.	$36,000.
TOTALS	$548,000.	$586,000.	$625,000.	$660,000.
EST. OPERATING COST/MT	$0.91	$0.84	$0.78	$0.73

6.6.4 SCHEME VI - OPERATING COST ESTIMATES

B. OUTBOUND PRODUCT (SULFUR) - UNLOADING FROM RAIL CAR, TO PRIMARY STORAGE, TO DOCK STORAGE TO VESSEL LOADING

Annual Throughput	200,000 MT	300,000. MT	400,000. MT
1. Operating Labour	$304,000.	$455,000.	$607,000.
2. Equipment costs (rental, rail freight, fuel & maintenance)	$207,000.	$311,000.	$414,000.
3. Power Consumption	$6,000.	$8,000.	$10,000.
TOTALS	$517,000.	$774,000.	$1,031,000.
EST. OPERATING COST/MT	$2.59	$2.58	$2.58

SCHEME VI

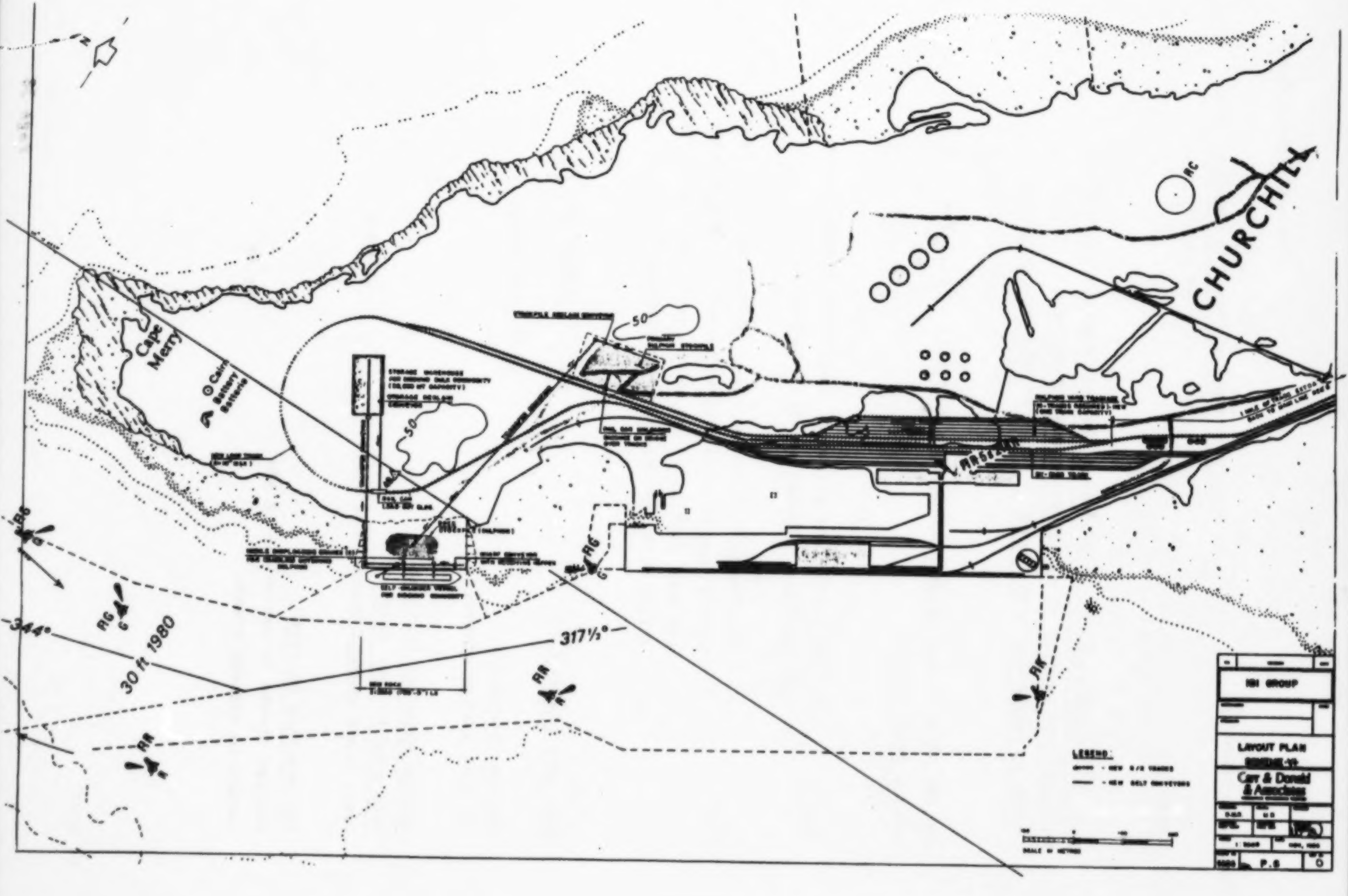
6.6.6 ADVANTAGES, DISADVANTAGES AND POSSIBLE RESTRICTIONS

ADVANTAGES

- Operating cost for inbound product substantially lower compared to Scheme IV. (Scheme IV is only other handling scheme for inbound product incorporating surge storage facility).
- No interference with Northern Transportation Co. or other operations over existing dock. No rail car movement required over existing dock.
- Provides for greater flexibility and combined throughput capacity of both inbound and outbound bulk commodities over single dock berth.
- Turnaround time for vessels handling inbound meterials much less than with schemes where vessel unloading with crane facility considered.

DISADVANTAGES AND POSSIBLE RESTRICTIONS

- Capital cost requirements higher than other schemes.
- New dock facility required, involving large capital expenditure.
- Maximum combined throughput of inbound and outbound commodities as projected for study purposes, could not be handled over the single berth, with the present season.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6.7 SCHEME VII

OUTBOUND FOREST PRODUCTS (PULPWOOD OR FINISHED PAPER) - LOADED INTO VESSELS AT EXISTING SOUTH BERTH USING SPECIAL TACKLE-EQUIPPED CRANES

100,000 MT of forest product brought to Churchill by rail for loading into vessels.

Case A - 100,000 MT of pulpwood transferred directly from open bulkhead pulpwood service, flat cars.

Case B - 100,000 MT of finished paper (rolls) unloaded from paper service box cars to dock apron utilizing specially equipped fork-lift type units, and then transferred to vessel with special gear-equipped cranes.

Reference Layout Plan	DRAWING No. P7
Maximum throughput (13 week marine season)	200,000 MT
Average Material handling rate over 10 hour shift (rail track storage yards to vessel)	150 MTPH
Car Handling Service Storage tracks to car unloading and return to storage tracks	By CN

6.7.1 SCHEME VII - CAPITAL COST ESTIMATES
(APPLICABLE TO CASES A & B)

1. Yard trackage for one train (140 cars) capacity, provided off existing track leading to dock berth	$1,770,000.
ESTIMATED CAPITAL COST-TOTAL	$1,770,000.

6.7.2 SCHEME VII - OPERATING COST ESTIMATES

Operating Cost Designation	CASE A (100,000 MT pulpwood)	CASE B (100,000 MT paper rolls)
1. Operating Labour at dock (rail car to vessel)	$147,000.	$210,000.
2. Equipment costs (rental, rail freight, fuel & maintenance)	577,000.	785,000.
TOTALS	$724,000.	$995,000.
OPERATING COST/MT	$7.24	$9.95

SCHEME VII

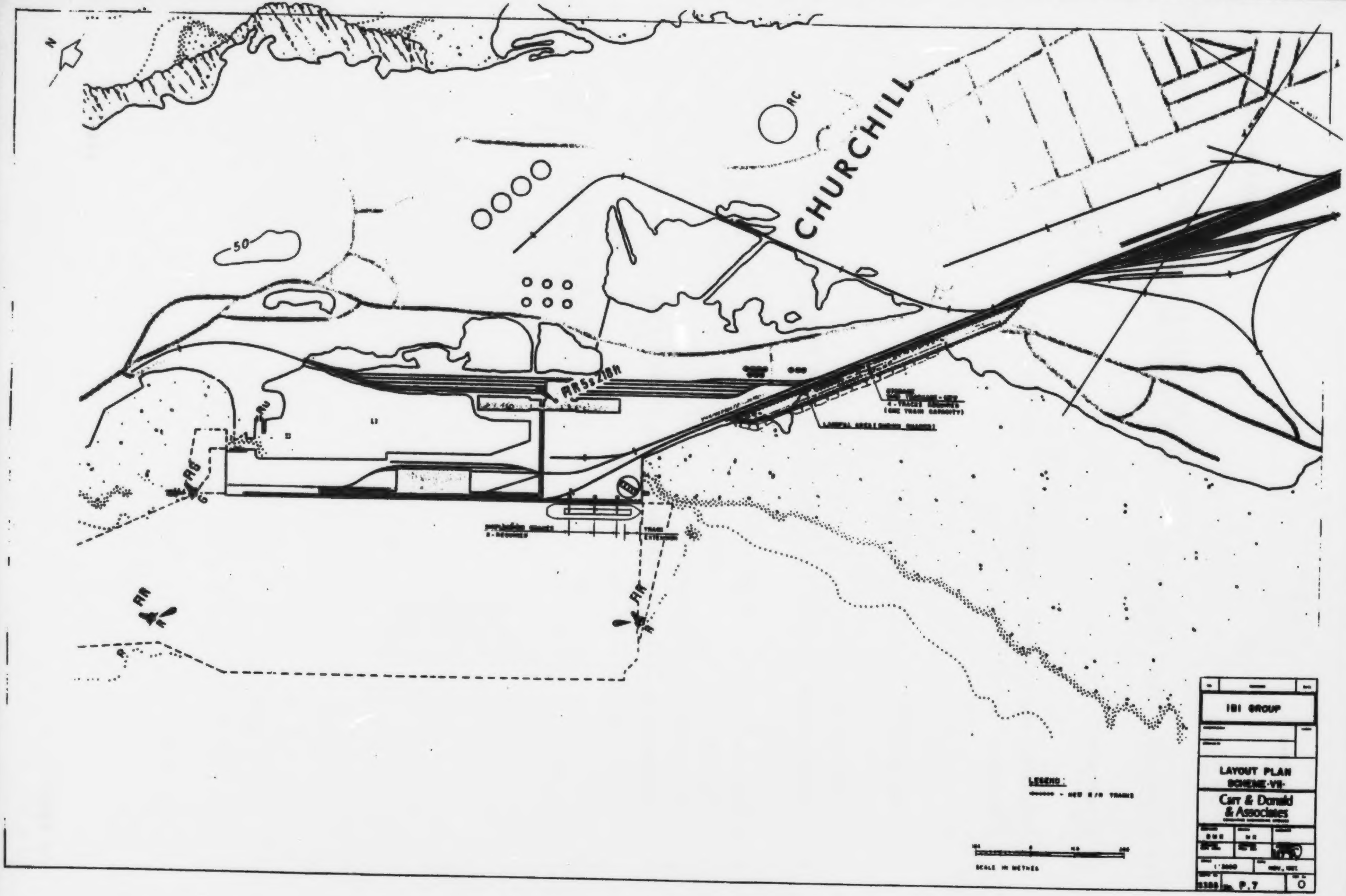
6.7.3 ADVANTAGES, DISADVANTAGES AND POSSIBLE RESTRICTIONS

ADVANTAGES

- Initial capital cost requirement relatively small
- Utilizes existing dock berth

DISADVANTAGES AND POSSIBLE RESTRICTIONS

- High operating cost.
- Requirements for rail car handling service from CN would occur at frequent intervals.
- Rail car handling operations would be required along track paralleling and adjacent to grain shipping gallery, with potential for interference when handling boat spouts.
- Alternate facility for accommodation of port service tugs etc, would likely be required.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6.8 SCHEME VIII

INBOUND AND OUTBOUND PRODUCT HANDLED OVER EXISTING DOCK AT NORTH BERTH

1. 300,000 MT OF INBOUND PHOPHATE ROCK BROUGHT TO CHURCHILL IN BOOM-EQUIPPED SELF-UNLOADING TYPE VESSELS.

   - Unload to dock conveyor equipped with one (1) movable receiving hopper. Transfer to land-based storage warehouse, (300,000 MT capacity) with two-flight transfer/elevating conveyor system, at rate of 2,000 MTPH.

   - Reclaim from storage with front-end loader onto receiving hopper-equipped conveyor for transfer/elevation to single car loading station at loop track, at rate of 1200 MTPH.

   - Indexing of cars through loading station with C.N road locomotives (unit train operation).

2. 1,140,000 MT (840,000 MT SULFUR AND 300,000 MT POTASH) BROUGHT TO CHURCHILL IN BOTTOM DUMP HOPPER CARS

   - Unload at 3 car capacity unloading pit serviced by terminal loop track and convey to either open sulfur stockpile, or covered potash storage warehouse, as applicable, at peak rate of 2,500 MTPH.

   - Reclaim from storage wit high capacity F.E.L. equipment, and convey to north dock berth at rate of 2,000 MTPH.

   - Load vessels at rate of 2,000 MTPH utilizing gallery-housed reversible shuttle conveyor paralleling dock berth and traveling, luffing type shiploader.

SCHEMME VIII

Reference Layout Plan	DRAWING NO. P8

Average material handling rates achievable over a 10 hour shift

Inbound Product

- vessel to storage	1,600 MTPH
- storage to car load-out	1,000 MTPH

Outbound Product

- car unloading to storage	2,300 MTPH
- storage to vessel loading	1,500 MTPH

Car Handling Service

Inbound and outbound product -	Unit train operation, with CN road locomotives

SCHEME VIII - CAPITAL COST ESTIMATES

6.8.1. OUTBOUND PRODUCT (SULFUR AND POTASH) - UNLOAD FROM RAIL CAR TO STORAGE, TO VESSEL LOADING AT NORTH DOCK BERTH

1. Three (3) car capacity rail car unloading unloading pit, foundation, superstructure, and receiving hopper	$5,000,000.
2. Handling - Unloading pit to storage - Conveyors, supporting structures and foundations	$2,000,000.
3. Sulfur stockpiling facility - Conveyor gallery structure, support piers, foundations and storage area preparation	$2,000.000.
4. Potash storage warehouse	$5,000,000.
5. Handling - storage to north dock berth - Conveyors, supporting galleries and foundations	$3,800,000.
6. Shiploading facilities - Shiploader and runway, shuttle conveyor feeding shiploader including gallery and foundations	$6,000,000.
7. Electrical services	$1,200,000.
TOTAL ESTIMATED CAPITAL COST	$25,000.000.

SCHEME VIII - CAPITAL COST ESTIMATES (Cont'd)

6.8.2. INBOUND PRODUCT (PHOSPHATE ROCK) - RECEIVED FROM SELF-UNLOADER VESSEL TO STORAGE, TO RAIL CAR LOADING ON TERMINAL LOOP TRACK

1. Handling - vessel to storage (conveyors, support structures and foundation)	$3,100,000.
2. Storage warehouse	$3,000,000.
3. Handling - storage warehouse to rail car load-out	$1,500.000.
4. Car load-out (load out building, foundations, loading chutes, surge hopper, track scale, etc)	$900,000.
5. Electrical services	$600,000.
TOTAL ESTIMATED CAPITAL COST	$9,100.000.

SCHEME VIII - CAPITAL COST ESTIMATES (Cont'd)

6.8.3. TERMINAL FACILITIES UTILIZED IN HANDLING OF BOTH OUTBOUND AND INBOUND PRODUCTS

1. Terminal rail loop track	$2,800,000.
2. Mobile material Handling equipment	$2,700,000.
TOTAL ESTIMATED CAPITAL COST	$5,500.000.

SCHEME VIII - OPERATING COST ESTIMATES

6.8.4. OUTBOUND PRODUCT (SULFUR AND POTASH) - CAR UNLOADING TO STORAGE, TO VESSEL LOADING - 1,130,000 MT THROUGHPUT

1. Operating Labour	$330,000.
2. Equipment Costs - (Fuel and maintenance only)	$170,000.
3. Power Consumption	$70,000.
TOTAL	$570,000.
OPERATING COST/MT	$0.504

6.8.5. INBOUND PRODUCT (PHOSPHATE ROCK) - UNLOAD FROM VESSELS TO STORAGE, TO RAIL CAR LOAD OUT - 300,000 MT THROUGHPUT

1. Operating labour	$106,000.
2. Equipments costs (fuel and maintenance only)	$64,000.
3. Power Consumption	$15,000.
TOTAL	$185,000.
OPERATING COST/MT	$0.617

SCHEME VIII

6.8.6. ADVANTAGES, DISADVANTAGES AND POSSIBLE RESCTRCTIONS

ADVANTAGES

- Provides for handling of both inbound and outbound product over single dock berth.
- Shiploading rate relatively high compared to that applying with other schemes involving handling of outbound product.
- Vessel turnaround time relatively short.
- Utilizes existing dock facility so that additional facility for ocean carriers not required.
- Operating costs per metric ton of material handled low.
- While permanent material handling facilities required at north dock area are more extensive than involved with other schemes utilizing north dock area. Degree of interference with Northern Transportation Company operations might be tolerable.
- No rail car movements over north dock area required.

DISADVANTAGES AND POSSIBLE RESTRICTIONS

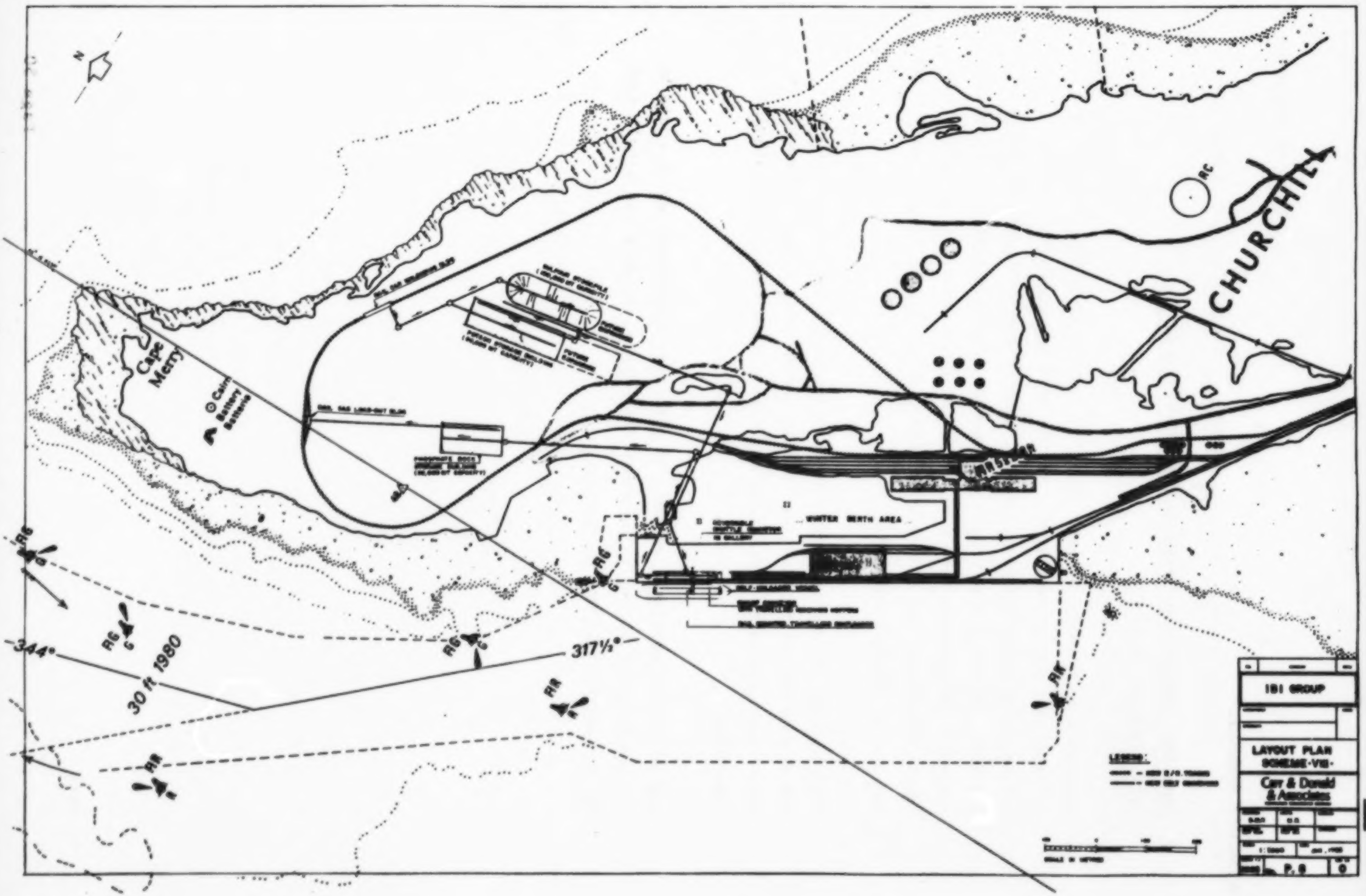
- Large initial capital expenditure required.
- Use of existing rail tracks at north dock area would be severely restricted.
- Interference with Northern Transportation Company operations might require provision of alternative dock facility for their operations.

SCHEME VIII

6.8.6. ADVANTAGES, DISADVANTAGES AND POSSIBLE RESCTRCTIONS (Cont'd)

DISADVANTAGES AND POSSIBLE RESTRICTIONS (Cont'd)

- With berth restrictions applying at Churchill, a large number of vessels (48 for the 30,000 DWT vessel size) would be required to be handled in a season. With the present season limite applying, this would require an average vessel turnaround time of less than two days, which from a practical standpoint is unlikely to be achievable on a continuing basis.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7. COMBINED INBOUND AND OUTBOUND THROUGHPUT CAPACITY OVER SINGLE DOCK BERTH

Schemes I to V inclusive all involve handling of either inbound or outbound non-grain commodities at the existing north dock berth. Scheme VI involves handling of both inbound and outbound non-grain commodities over a new single dock berth. Combinations of inbound and outbound throughputs have been evaluated over the existing north dock berth, or over a new single dock berth, given the facilities considered for the individual schemes.

With inbound throughput over the existing north dock at 200,000 to 300,000 MT utilizing handling faciity and methods as per Scheme I, it would not be possible to handle any appreciable tonnage of outbound commodity.

The estimated combined inbound and outbound throughputs which could be accommodated at the existing north dock berth, or at a new single dock berth, are as follows:

7.1 INBOUND AND OUTBOUND THROUGHPUT COMBINATION CAPACITIES FOR OPERATIONS UTILIZING EXISTING NORTH DOCK BERTH *

Scheme	Inbound Throughput	Outbound Throughput
	(MT)	(MT)
Inbound per Scheme II and Outbound per Scheme V	400,000	-
	300,000	50,000
	200,000	180,000
	100,000	320,000
Inbound per Scheme III and Outbound per Scheme V	500,000	80,000
	300,000	230,000
	100,000	380,000
Inbound per Scheme IV and Outbound per Scheme V	700,000	100,000
	500,000	200,000
	300,000	300,000
	100,000	400,000

* Throughput estimated assume a 13 week marine shipping season at Churchill. With extended season, seasonal throughput capacity would be proportionally greater, assuming that ice conditions would not result in interruption of arrivals and departures of vessels.

7.2 INBOUND AND OUTBOUND THROUGHPUT COMBINATION CAPACITIES FOR OPERATIONS UTILIZING A NEW SEPARATED DOCK AS PER SCHEME VI

ASSUMPTIONS

1. Dock operating season, 13 weeks (for extended season, inbound, outbound, and combined throughput capacities would be proportionally greater).

2. Inbound material received in boom-equipped self-unloading vessel, with unloading rate of 2000 MTPH.

3. Outbound material loaded into vessels with two clam-equipped cranes at a combined rate of 400 MTPH.

4. Flow of inbound and outbound material at a uniform rate over the season.

Sulfur Outbound Throughput (MT) (sulfur)	Inbound Throughput (MT)	Combined Totals (MT)
50,000	900,000	950,000
100,000	840,000	940,000
150,000	750,000	900,000
200,000	660,000	860,000
250,000	570,000	820,000
300,000	470,000	770,000
350,000	360,000	710,000
400,000	240,000	640,000

With regard to costs, capital costs attributable to handling facilities for inbound and outbound commodities would remain unchanged from those assessed for the individual inbound and outbound schemes, as none of the capital cost items allowed for would provide facility for handling both inbound and outbound commodities.

APPENDIX F

ESTIMATED TERMINAL CHARGES FOR JOINT BULK COMMODITY MOVEMENTS THROUGH CHURCHILL ASSUMING LONGER ECONOMIC LIFE FOR NEW TERMINAL FACILITIES

EXHIBIT F.1

TERMINAL CHARGES FOR JOINT BULK COMMODITY MOVEMENTS THROUGH CHURCHILL ASSUMING LONGER ECONOMIC LIFE FOR FACILITIES*

COMMODITY SCHEME	OUTPUT (TONNES)			CAPITAL COSTS ($)						OPERATING COSTS ($)	TOTAL ANNUAL COSTS ($)	TOTAL COST/ TONNE ($)
	THROUGHPUT INBOUND	THROUGHPUT OUTBOUND	TOTAL THROUGHPUT	WHARF	LOADING FACILITIES	TRACK	STORAGE BUILDINGS/ FACILITIES	TOTAL	ANNUAL CAPITAL			
1. Sulphur to Europe and U.S.S.R.		210,000	210,000		1,200,000	2,350,000	400,000	3,950,000	454,870	1,820,500	2,275,370	10.84
2. Potash to South America with Year-Round Rail Shipment to Churchill		290,000	290,000		14,800,000	2,800,000	5,000,000	22,600,000	2,721,560	194,900	2,916,460	10.06
2b Potash to South America		72,500	72,500		14,800,000	2,800,000	3,500,000	21,100,000	2,555,660	50,000	2,605,660	35.94
3a Sulphur to Europe and U.S.S.R. and Potash to South America		210,000 (sulphur) 72,500 (potash) 282,500	282,500		14,800,000	2,800,000	5,500,000	23,100,000	2,776,860	190,000	2,966,860	10.50
3b Sulphur to Europe and U.S.S.R. and Potash to South America with Year-Round rail shipment of Potash to Churchill		210,000 (sulphur) 290,000 (potash) 500,000	500,000		14,800,000	2,800,000	7,000,000	24,600,000	2,942,760	337,000	3,279,760	6.56
6a Sulphur to Europe and U.S.S.R., Potash to South America with Phosphate Rock Backhaul from Florida	75,000	210,000 (sulphur) 72,500 (potash) 282,500	357,500		15,200,000	2,800,000	5,900,000	23,900,000	2,871,340	850,000	3,721,340	10.41
6b Sulphur to Europe and U.S.S.R., Potash to South America with Phosphate Rock Backhaul from Florida and Year-Round rail shipment of Potash and Phosphate Rock to/from Churchill	300,000	210,000 (sulphur) 290,000 (potash) 500,000	800,000		26,800,000	2,800,000	10,000,000	39,600,000	4,781,760	437,000	5,218,760	6.52

Amortization Rate - 11%

* Life Expectancy:
Wharf - 50 years
Loading Facilities - 20 years
Trackage - 50 years
Storage Facilities - 50 years